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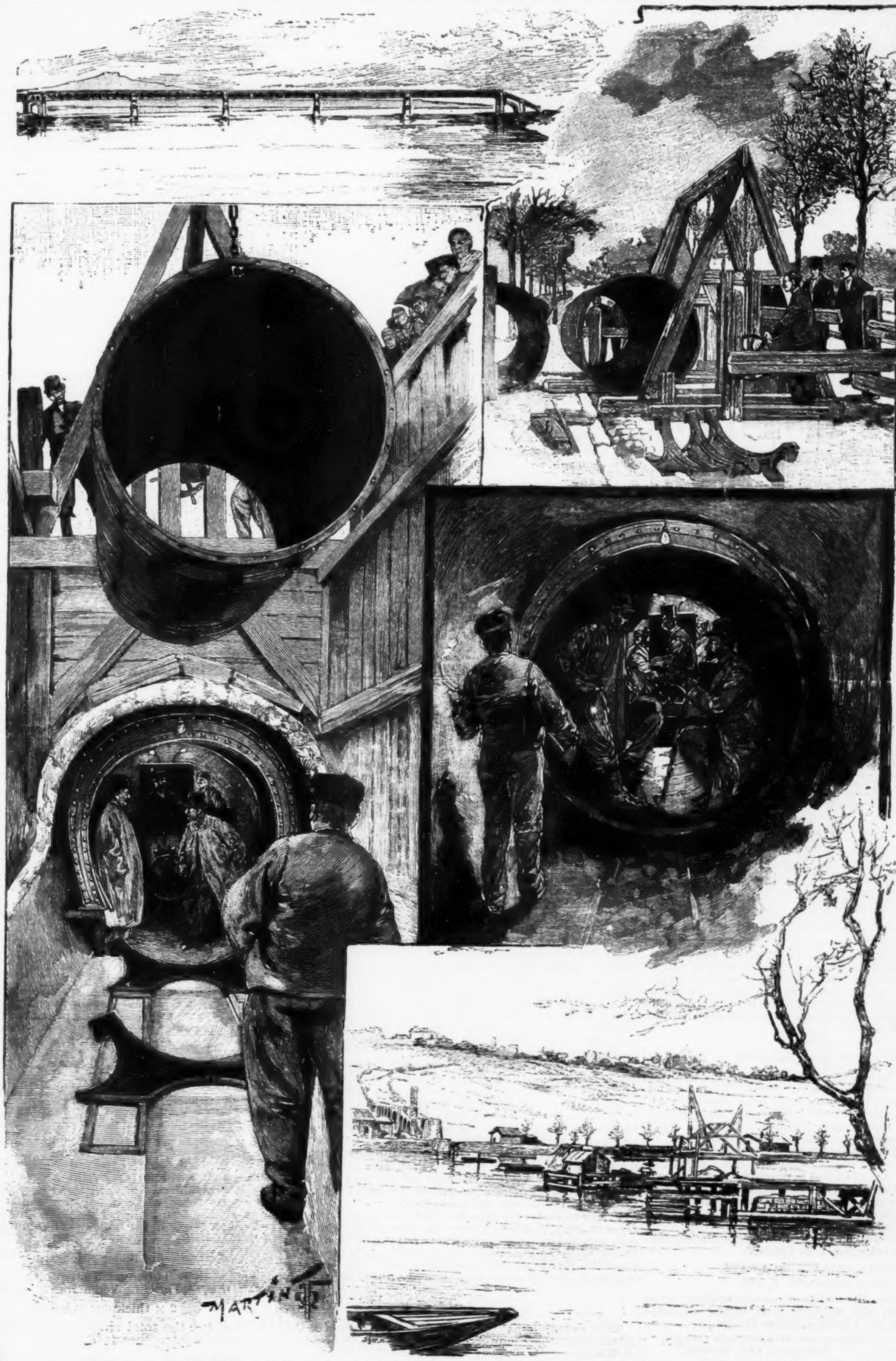

1. Bridge over the Seine. 2. On the Boulogne road. 3. Lowering the pipes. 4. The engine in operation. 5. Present state of the work on the bridge.

THE CONDUIT FOR THE WATER OF THE AVRE.

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The earthwork and masonry, begun last year, are entirely finished from the Auteuil viaduct to the Seine. They follow the route as far as to the gate of Boulogne, and, from there, running along the Loup du Bois Falls, end at the bridge constructed by Eiffel and now approaching completion.

For some days past the operation of putting the pipes in place has been going on. The route is provided with these for its entire length. At about 1,600 ft. from the Auteuil station the sewer has been opened, and a scaffolding here serves for the lowering of the pipes. In the first place, the cast iron supports are lowered and placed at the exact distance apart that they are to have when they are put in position; then the pipes are lowered and placed very accurately upon the supports. These pipes are 19¼ ft. in length and 5 ft. in external diameter, and weigh 11,000 lb. A special carriage, moved by an electric machine, is placed astride the pipe, which is then lifted by means of jacks or hydraulic pumps, four in number, provided with a yoke, which is hooked to each side of the supports. Nothing remains but to start. The carriage is then set in motion, and carries the pipe to its destination. Then, by means of the pumps, it is lowered until it comes exactly in face of the one that has preceded it. There is a special apparatus used for the adjusting of the pipes. Finally, after each is in place, the carriage runs back to its starting point, while the workmen proceed to the work of adjusting and bolting.

After the pipes have been laid as far as to the gate of Boulogne, a new opening will be made, through which to lower them, and from there they will extend to the Seine and pass over the aqueduct. The reservoirs are at Montretout. The work on them is being rapidly pushed forward, and the first ought to be finished next year.—*Le Monde Illustré.*

DISTANCE RUN IN EMERGENCY STOPS AT VARIOUS SPEEDS.

The table shows distances run with air-braked trains in emergency stops at various speeds. The stops are equated on a new basis. This table includes, we believe, all authentic stops, of record, which have been made up to this date in this country with a quick acting, compressed air brake, operated solely by air. Seventy per cent. of the total train weight is braked. The results are such as can be duplicated in actual service with the same proportion of pressure on brake shoes.—*Railroad Gazette.*

Brake.	Speed, miles per hour.	Distance, ft.	Grade, ft. per mile.	Train pipe pressure, lbs.	Distance run before brakes apply.	Distance run after brakes apply.	Equivalent distance on level.	Equivalent distance, 70 lbs. press. in train pipe.
Westinghouse, 1887	19	172	13.6	70	60	116	113	113
" "	36	490	13.6	70	106	381	376	376
" "	22	184	....	70	64	120	120	120
" "	37	430	....	70	108	372	372	372
" "	20	176	52.8	70	58	118	109	109
" "	36	507	52.8	70	106	401	309	339
" "	25	284	50.0	70	74	210	193	193
" "	35	512	50.0	70	102	410	401	401
" "	23	285	40.0	70	76	180	178	178
" "	43	718	40.0	70	126	692	641	641
" "	21	214	32.2	70	62	152	143	143
" "	40	679	32.2	70	114	565	533	533
" "	20	158	35.0	70	58	100	96	96
" "	36	580	35.0	70	104	454	426	426
" "	19	123	40.0	70	56	67	64	64
" "	32	406	40.0	70	94	312	293	293
" "	23	204	53.0	70	68	136	126	126
" "	41	674	53.0	70	120	554	507	507
" "	23	264	44.0	70	68	196	180	180
" "	36	593	44.0	70	106	487	448	448
" "	19	159	52.0	70	56	103	95	95
" "	42	694	52.0	70	124	570	523	523
" "	20	194	47.0	70	58	136	125	125
" "	40	649	47.0	70	118	531	490	490
Westinghouse at Burlington, 1892	23	239	....	70	68	171	171	171
" "	30	381		70	88	293	296	296
" "	19	162	53.0	72	56	106	98	101
" "	36	646	53.0	70	106	540	483	483
" "	23	282	....	72	68	214	214	220
" "	32	386	....	71	94	292	292	296
" "	22.5	238	53.0	68	66	172	157	153
" "	33.5	561	53.0	68	98	463	414	402
" "	24.5	283		68	72	211	211	205
" "	31	417	....	67	91	326	316	312
" "	21	190	53.0	69	62	128	119	117
New York at Burlington, 1892	15	93	....	70	44	49	49	49
" "	26	297	....	72	76	221	221	227
" "	31	300		70	91	209	209	209
" "	18	156	53.0	70	53	103	94	94
" "	26	571	53.0	70	106	468	425	425

CHINESE RAILROADS.

Late advices from Tientsin state that by the direction of the Viceroy the Imperial Chinese Railway and the China Railway Company have been consolidated, and the management has been intrusted to Yang Hung-Tien Taotai as managing director. He will have charge of the finances and official matters.

The position of assistant managing director has been given to Mr. W. N. Pethick, who will have charge of the operation of the road and is practically the general manager. Mr. Pethick is a New Yorker, who served in our army during the war; he is a practical railroad man and has been in China long enough to understand the country and the people well.

For the benefit of our readers we append a translation of General Order No. 1, as follows:

IMPERIAL CHINESE RAILWAYS.

General Order No. 1, 1891.

Notification from the assistant managing director on taking charge of the working staff of the Imperial Chinese Railway and China Railway Company.

Managing Director's Office,
Tientsin, Oct. 10, 1891.

To all employes of the Imperial Chinese Railway and China Railway Company:

On October 9, 1891, I had the honor to receive the following instructions from His Excellency the Grand Secretary and Viceroy Li, Director General of Imperial Railways:

"It is hereby ordered that the head offices of the Imperial Railway and the China Railway Company be now consolidated and placed under a managing director and an assistant managing director, whose responsibilities shall be divided as follows:

"Receipts and disbursements of money, employes in the finance department, and Chinese official correspondence and accounts, to be in charge of Yang Taotai, who shall prepare monthly statements of the accounts.

"Mr. W. N. Pethick, of my foreign staff, is appointed assistant managing director of both lines, with full charge of the working staff at the stations, storehouses, wharves, etc. He is not to be concerned with finances, finance staff, secretaries' staff or relations with Chinese officials. He is to have control over stations, godowns, wharves, telegraph offices, and all interpreters, assistants, and workmen, both native and foreign, in the ordinary course of business. All stores of materials for both lines and their issue as required shall likewise be in his charge. He will be required to frequently visit the stations, etc., and keep careful oversight of them; he is to act justly in employing or discharging people as they may deserve, and see that every employe faithfully performs his duties, obeys rules, and practices economy; and he is to be careful that native employes are properly trained and disciplined, so that mistakes and malpractices may be prevented.

"Let those concerned carry out these orders thoroughly, and so justify hope for substantial improvement in the service.

"Copies of this order will be sent to T'ang Taotai, Li Taotai, and General Chou for their guidance."

The respective functions of the managing director and the assistant managing director are now clearly defined; and it will be my duty to report to the managing director any business of unusual importance.

My special responsibility is the entire control of the working staff and of the ordinary routine business of the whole line. This has been made by my superiors a separate department, in order that one man may deal promptly with the numerous matters affecting the staff constantly requiring attention.

On assuming these duties I desire to make known to all employes of both lines the plan I intend to follow, and the assistance I shall expect from every one, so that there may be a clear understanding and perfect accord between us.

1. *Caution.*—The most important of all things is safety of life and property carried on the line. Everything else is subordinate to this, and the first care of every employe must be to prevent danger. On railways, the safety of all depends on the faithfulness of every man in the service; the fault of one may cause great disaster. To obtain safety it is necessary that every one should exercise caution and forethought, and faithfully perform all his duties.

2. *Diligence.*—Duties must be performed promptly and thoroughly. What should be done to-day must not be put off until to-morrow. Opium smoking, gambling, carousing and associating with dissolute or idle people are prohibited. No one can do his work well without exercising self-respect.

3. *Honesty.*—Strict honesty must be observed in all business. No one must take advantage of his position to seek private gain. It is intended to pay all employes adequate salaries, so that there will be no excuse for speculation, extortion or bribery. Any one found guilty of dishonest practices will be immediately discharged and handed over to the authorities for punishment.

4. *Courtesy.*—This must be exercised at all times, and especially toward the public who make use of the railway. No passenger or shipper must be treated rudely or taken advantage of in any way. The railway is for the public convenience, and the good will of the public will be obtained by courteous treatment.

5. *Obedience.*—Orders and instructions given by those in authority must be obeyed promptly and fully. Disobedience of orders will not be excused in any one. This must be carefully remembered by all who wish to remain in the service.

I ask all employes, high or low, to give heed to these matters, and thus contribute to the success and good repute of the service. I shall take pains to know personally every member of the service, and how he performs his duties. I shall take pleasure in rewarding those who exert themselves, and will certainly dismiss or have otherwise punished those unworthy of confidence. Bad conduct or neglect of duty will not be overlooked. All should reflect that they are serving the country in an important new enterprise which will benefit government and people if successful. If each does his duty, success will be certain.

In future, instructions to the staff will be issued in the form of general orders, printed in Chinese and English, and numbered consecutively. A copy will be sent to every employe concerned, and such orders must be carefully preserved and frequently read. No one who has disobeyed an order need then plead ignorance of it.

W. N. Pethick,
Assistant Managing Director.

This order seems to be addressed chiefly to the Chinese employes, and is a sort of primary instruction or condensed elementary treatise on their duties. At the same time Mr. Pethick issued the following circular, which is especially addressed to the members of the foreign staff; the headings, etc., are omitted, giving only the substance of the order:

Gentlemen: Having been appointed by H. E. the Viceroy to the position of assistant managing director, with control of the working staff and the ordinary business of both lines, I beg to inform you that I shall give special attention to measures for facilitating the prompt and efficient transaction of public business, and shall be glad to make such changes as may be for the good of the service.

To this end I trust that I may count on your co-operation. H. E. the Viceroy having determined to give foreign management a fair trial, the duty devolves upon all of us to do what we can to justify this expression of confidence in foreign integrity and business methods; for it is the system more than the individual that will be on trial.

I particularly invite your attention to the first great essential of success—safety of life and property on the line. There are many factors in this problem; and I shall always be glad to receive and carefully consider practical suggestions bearing on any branch of the subject.

I would also ask you to remember at all times the importance of exercising courtesy and forbearance in dealing with the natives. There is often much to provoke or exasperate, but on no account should violence be used toward them, save only in defense of life. Nor should violent or abusive language be used. Adequate punishment for real offenses will be found in discharging or fining the offender, or suspending him from duty; and if more severe punishment is deserved, it can be administered in due form of law by the local official having jurisdiction. It is always possible to exercise firmness or do justice without show of violence. Nothing causes us loss of prestige more than a habit of giving way to angry passions.

Being in China, I do not expect to take part in any rapid transformation scenes. Reform and improvement will have to work their way gradually, but I hope none the less surely and thoroughly.

Mr. Pethick being an American and familiar with American methods, it is probable that they will be followed to a great extent in the management of the road, and in building its extensions, should any be undertaken hereafter.—*Railroad and Engineering Journal.*

THE BURSTING PRESSURE OF CYLINDRICAL BOILERS.

Several correspondents have recently asked for an explanation of the rule for finding the bursting pressure of boiler shells. The following article is offered as a general answer to all of these inquiries.

Fig. 1 shows an end view of such a shell, with the thickness purposely exaggerated. Let us assume that when the shell bursts it will separate along the line AB, so as to come apart in the manner indicated in Fig. 2. Now, although the steam pressure acts perpendicularly to the curved shell at every point, as indicated by the arrows, yet, so far as blowing the two halves of the boiler apart is concerned, the *effect* is the same as though the steam pressure acted vertically against a flat plate equal to the boiler in length and equal in width to the diameter of the boiler. To make this plain, let us consider Fig. 3, which shows each half of the boiler with a flat plate welded to it along its open side. Now it is a matter of common experience that a structure like one of these halves will not move upward or downward when steam is admitted to its interior. That is, if it were put on a pair of scales the pressure of the steam against its inner surfaces would not make it weigh less or more than before. It follows, therefore, that the total *upward* pressure of the steam against the shell is precisely equal to the total *downward* pressure against the flat plate; the greater area of the curved shell being exactly compensated by the obliquity of the pressure against it.

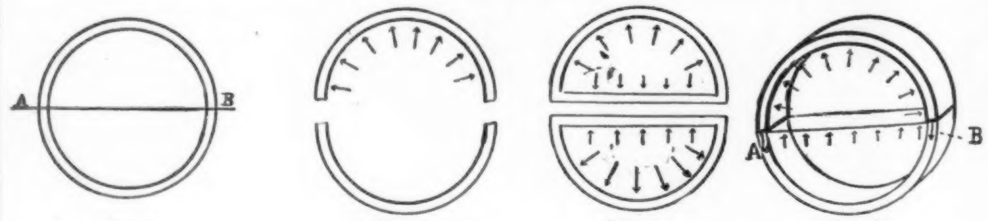


Fig. 1 Fig. 2 Fig. 3 Fig. 4

THE BURSTING PRESSURE OF CYLINDRICAL BOILERS.

Let us now consider Fig. 4. The total *upward* pressure of the steam against the upper half of the shell is equal, as we have seen, to the pressure against a flat plate such as that shown in the cut, extending across the middle of the boiler. That is, it is equal to

Pressure per sq. in. × area of flat plate.

But the area of the flat plate is equal to the length of the boiler multiplied by its diameter; so that the total upward pressure, tending to blow off the upper half of the boiler, is equal to

Pressure per sq. in. × diameter × length.

This upward force is resisted by the strain on the boiler shell, as indicated by the arrows at A and B. The total strain on the shell is equal to the strain on one square inch of sectional area multiplied by the number of square inches of sectional area that would be broken across if the boiler should burst. The area of the fracture along each side of the boiler would be

Thickness of boiler × length of boiler,

and since there is one such strip on each side of the boiler, the total area broken across would be

2 × thickness × length,

and therefore the total strain at A and B, tending to hold the boiler together, is

2 × strain per sq. in. of section × thickness × length.

So long as the boiler does not burst, the force tend-

ing to blow it apart must be exactly equal to the force tending to hold it together; so that

Pressure per sq. in. × diameter × length = 2 × strain per sq. in. × thickness × length.

This is equivalent to saying that

Pressure per sq. in. × diameter = 2 × strain per sq. in. × thickness.

And this, again, is equivalent to saying that

Pressure per sq. in. × radius × 2 = 2 × strain per sq. in. × thickness.

That is,

Pressure per sq. in. × radius = strain per sq. in. × thickness.

Now, when a boiler bursts it does so because the strain on the shell has become equal to the tensile strength of the material; so that in this case our last formula becomes

Bursting pressure × radius = tensile strength × thickness.

This is the ordinary rule for finding the bursting pressure of a cylindrical boiler, except that it is usually expressed in the following slightly different manner:

$$\text{Bursting pressure} = \frac{\text{tensile strength} \times \text{thickness}}{\text{radius}}$$

The bursting pressure of a boiler shell, therefore, is found by multiplying the tensile strength of the material in pounds per square inch by the thickness of the shell in inches, and dividing by the radius in inches.

In this demonstration we have assumed the shell to be a solid sheet of metal, without joints. In practice the strength of a boiler is reduced exactly in proportion to the strength of its longitudinal joints, so that we must multiply the result obtained by the foregoing rule by the decimal representing the efficiency of the joint. (The question of the efficiency of joints has been so frequently and fully considered in the *Locomotive* that it is not necessary to discuss it in this place.) The foregoing formula therefore becomes

$$\text{Bursting pressure} = \frac{\text{tensile strength} \times \text{thickness} \times \text{efficiency of joint}}{\text{radius}}$$

which means that in actual boilers we find the bursting pressure by multiplying the tensile strength of the material by the thickness of the plate *and by the efficiency of the joint*, and then dividing by the radius.

In conclusion we shall give a few numerical examples of the use of the foregoing formula and rule.

Example 1.—What is the bursting pressure of a steel boiler (tensile strength 55,000 lb.), 48 inches in diameter and $\frac{5}{16}$ inch thick, with single riveted longitudinal joints whose efficiency is 56 per cent.? *Ans.*—The radius of this boiler is 24 inches, so that the rule gives

Bursting pressure =
$55{,}000 \times \frac{5}{16} \times {\cdot}56 \div 24 = 401$ lb. per sq. in.

Example 2.—What is the bursting pressure of a steel boiler (tensile strength 55,000 lb.), 60 inches in diameter and $\frac{3}{8}$ inch thick, with double riveted longitudinal joints whose efficiency is 70 per cent.? *Ans.*—The radius is 30 inches, and the rule gives

Bursting pressure =
$55{,}000 \times \frac{3}{8} \times {\cdot}70 \div 30 = 481$ lb. per sq. in.

Example 3.—What is the bursting pressure of a steel boiler (55,000 lb. tensile strength), 66 inches in diameter and $\frac{3}{8}$ inch thick, with triple riveted longitudinal joints whose efficiency is 75 per cent.? *Ans.*—The radius of this boiler is 33 inches, and the rule gives

Bursting pressure =
$55{,}000 \times \frac{3}{8} \times {\cdot}75 \div 33 = 469$ lb. per sq. in.

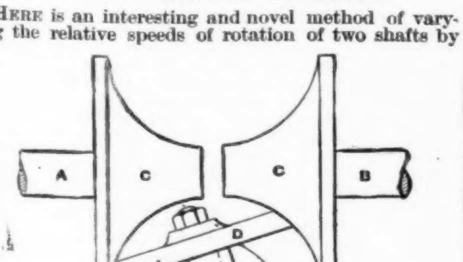
Example 4.—What is the bursting pressure of a steel boiler (tensile strength 55,000 lb.), 72 inches in diameter and $\frac{3}{8}$ inch thick, with double welt butt longitudinal joints whose efficiency is 87·5 per cent.? *Ans.*—The radius is 36 inches, and the rule gives

Bursting pressure =
$55{,}000 \times \frac{3}{8} \times {\cdot}875 \div 36 = 501$ lb. per sq. in.

After we have found the bursting pressure, the safe working pressure may be found by dividing the bursting pressure by a suitable factor of safety. We consider 5 to be the best factor of safety when all things are considered, though we sometimes allow $4\frac{1}{2}$ when the workmanship is known to be first class, and the materials of which the boiler is made have been carefully selected and tested. With a factor of safety of 5, the safe working pressures in the foregoing examples are as follows: Example 1, 401 ÷ 5 = 80 lb.; in Example 2, 481 ÷ 5 = 96 lb.; in Example 3, 469 ÷ 5 = 94 lb.; and in Example 4, 501 ÷ 5 = 100 lb.—*The Locomotive.*

NOVEL FRICTION GEARING.

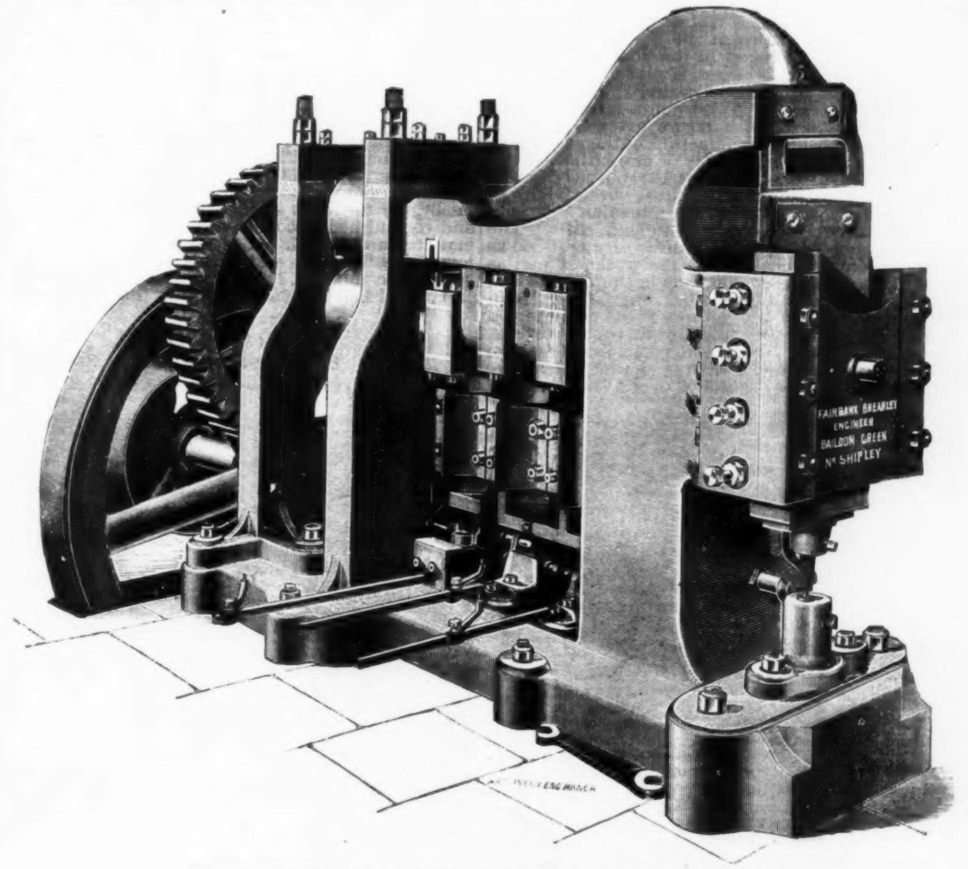
HERE is an interesting and novel method of varying the relative speeds of rotation of two shafts by



friction gearing, by C. C. Yates, of Mechanics' Falls, Me. On the ends of two shafts, A and B, are fixed two conical wheels, C and C. Between these is an intermediate wheel bearing on both of the cones. This wheel or disk, D, is mounted on a swiveling plate, E, so as to be set at various angles to the axis of the shafts, A and B, bearing at its periphery on the cones, C, at corresponding distances from the center, and varying their relative motions accordingly. The peculiarity of the gearing, apart from its extreme simplicity, is that the surfaces move together uniformly, and there is not, it is claimed, that twisting and grinding action common to some forms of friction gearing.

IMPROVED SPRING FORGING MACHINE.

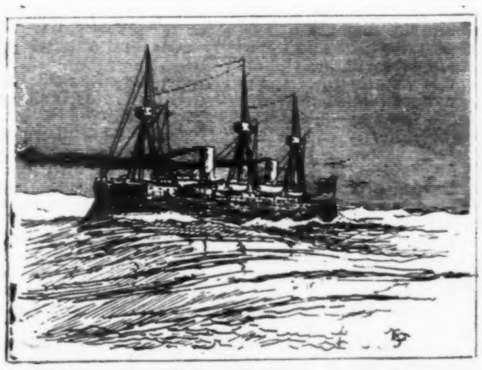
THE engraving given below represents a general view of an improved spring forging machine made by Mr. Fairbank Brearley, engineer, of Baildon Green, near Shipley, Yorkshire. The machine has been so designed that springs can be forged at one heat. It consists essentially of a pair of shears in the front of the machine, a punch operated by slide mechanism, a cropper for rounding off the ends of a spring, a squeezer for tapering the spring edgewise, and also what is known as the "nib and slit"—the slit for punching the slot holes and the nib for compressing a piece to fit into them; a chilled roller and plate for tapering the spring lengthwise, the former being provided with adjustable necks, so that it can be adapted to any size of steel suitable for carriage springs. As will be seen, the machine is powerfully built, having substantial gearing and a heavy flywheel. All the punches and shears are operated by eccentrics fitted on the main shaft, which is of mild steel.—*Industries.*



IMPROVED SPRING FORGING MACHINE.

THE NEW GREEK TURRET SHIP SPETZIA.

THE Spetzia, which, its constructors aver, is the most powerful warship of its tonnage afloat, has recently left Havre, where she has just been completed, for the Piræus. She is one of three sisters ordered in France by the Greek government, the others being the Hydra and Psarsa. The ship's speed at her trial was 17·5 knots, that pace being maintained for three hours. The Spetzia is armored with a continuous belt of 12 inch compound armor at the water line, and has four inches of steel over the remainder of her freeboard. She carries three 10·6 inch guns and five 5·9 inch Canet guns, besides a strong battery of Hotchkiss quick firing and machine guns. She has further three torpedo ejectors. The Spetzia's displacement is 4,885 tons, her length 334 ft. and her beam 51 ft. 10 in. She carries a complement of 400 men.

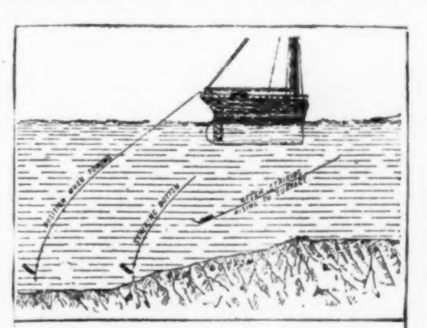


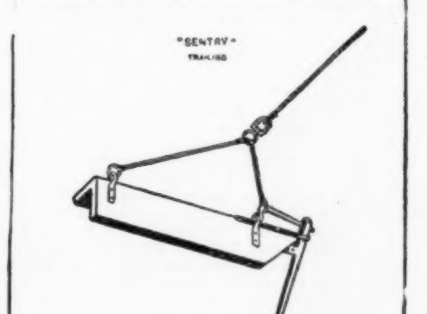
THE NEW GREEK TURRET SHIP SPETZIA.

A SHOAL WATER SIGNAL.

THIS is intended to give a continuous under-water look-out, and automatically to give warning of the approach of shallow water. It consists, says the *Daily Graphic*, of an inverted wooden kite, which can be trailed from the stern of a vessel at any required depth to forty-five fathoms. On striking bottom the blow, acting on a projecting trigger, releases the slings of the kite, and causes it at once to rise to the surface and trail in the wake of the vessel. At the instant of striking the sudden loss of tension in the wire sounds a gong attached to the winch on board. During towing the vibration of the wire causes a continuous rattle in a sounding box, and the cessation of this noise gives an additional indication when the "Sentry" has struck bottom. The vertical depth of the kite at any time is indicated on the dial plate of the winch. It is not intended that the machine should be used at speeds greater than thirteen knots. It could be adapted for higher speeds, but this is not considered necessary. A captain doubtful as to his position, and anxious about the depth of water under him, would hardly steam at a greater rate than thirteen knots.

With regard to the working of the "Sentry." The kite or sinker is first slung according to instructions and it is then lowered to the surface of the water. Then, easing out the wire tow line rapidly by means of a brake, the heavy end of the sinker dips; the strain of the passing water acts on the whole, and down it





goes straight to its position, the sounding box immediately setting up its rattle. On running into the depth set for, the trigger strikes the bottom, releases the sling of the kite, which floats on the surface. The rattle of the sounding box ceases, which the lookout man attending the machine reports; the ship's speed is slowed, and

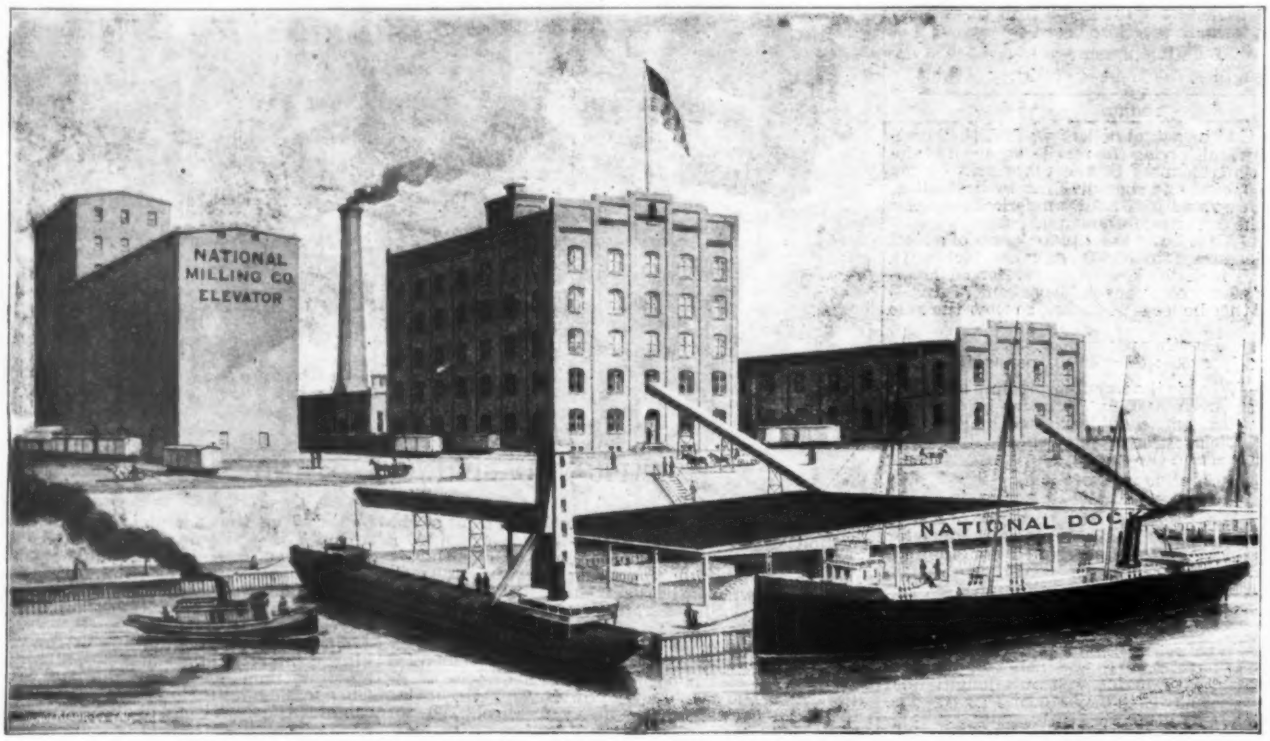
the sounding verified. With a little practice, one person can put the sinker overboard, take the sounding, and reel in again. In a trial of this machine, in the Firth of Clyde, a new bank was discovered by its means, on which the depth was found to be as little as 6½ fathoms where the chart showed 26 fathoms.

THE NATIONAL MILLING COMPANY'S NEW PLANT AT TOLEDO, OHIO.

TOLEDO being the largest winter wheat market in the West and having the advantage of deep water navigation, excellent railway facilities, besides the benefits derived from cheap fuel, being the lake shipping point for the numerous coal mines of Ohio and in the oil and gas belts, gives that point a great advantage as a manufacturing center, which many capitalists are taking advantage of, notably among whom is the National Milling Company, in which Boston and Toledo parties are interested, and of which Mr. C. L. Cutter, who has been actively engaged in the flour and milling business for over twenty years, is manager and secretary and Albert B. Cutter treasurer. This concern was induced to locate at Toledo on account of these numerous advantages which insure everything necessary to the economical manufacture of their products, certainty of an abundant supply of grain (the elevator capacity of Toledo being over 12,000,000 bushels), as well as the unexcelled shipping facilities, several lines of steamers running to Erie, Buffalo, Canadian and other lake ports, as well as direct to foreign parts. The National Milling Company's plant is distinguished as the largest winter wheat mill in the world, as well as being the finest and most complete in equipments ever constructed, is favorably located on the Belt Railroad, connecting with the eighteen roads centering in Toledo and with a water frontage of 300 ft., and extending back 700 ft., each department communicating with the company's docks and switches, of which there are seven, with a combined length of over 4,000 ft., and all arranged in such a manner as to facilitate the handling of grain and ground products in a rapid and economical manner. The main mill building is 82 ft. × 116 ft. with 16 ft. basement; first, second, third and fourth stories, each 14 ft., and fifth 22 ft., all easily accessible by means of a passenger elevator.

The mill is divided into two sections, each having a capacity of 2,500 barrels and operated independent of each other. The half now in operation is equipped with 10 in. double roller mills, three pairs high 9 in. screenings mills, round reel scalpers and dressers, return air purifiers, bran and ship's dusters, all the design and product of the Nordyke & Marmon Co., Indianapolis, Ind. There are, also, in this section of the mill 10 sieve purifiers, 9 flour and 3 bran packers. A novel feature in the packing department is the packing of bran with the "Falcon Bran Packer," manufactured by the Nordyke & Marmon Co. This packs an equal number of pounds of bran in the same space required by the same number of pounds of hard packed flour.

The power plant is located in a building 75 ft. by 100 ft., adjoining the mill, and consists of a compound condensing Corliss engine rated at 700 horse power, supplying power for the section of the mill now completed. A 150 horse power automatic engine drives the elevator and a separate engine the electric light plant, the interior of all buildings being lighted by incandescent electric lights and the yards and docks by arc lights. Steam is supplied for the engines by two sets of Sterling water tube safety boilers. The buildings are heated by steam from an independent boiler. A fire pump is also located in the power house, which connects with hydrants situated at convenient points about the buildings, which, in connection with the automatic fire sprinklers with which the plant is equipped, combined with the judicious arrangement and construction of the machinery, reduces the fire risk to the minimum and enables the insurance to be placed at an unusually low rate in the best stock companies. Power is transmitted to elevator by rope transmission through a tunnel under railroad tracks, through which grain is also conveyed from elevator to mill, which are 36 ft. apart. The elevator has a capacity of 500,000 bushels and is equipped with four receiving separators capable of handling 15,000 bushels per hour, also four 1,200 bushel hopper scales, and so arranged that the grain may be cleaned before or after weighing, as desired. Belt conveyors are employed exclusively in the elevator. With their facilities for handling grain they can unload and take care of 10,000 bushels per hour from cars and at the same time 5,000 bushels per hour from vessels. The cleaning machinery for each half of mill, aside from that noted above, is located in the mill, and consists of a double line, as follows: Two milling separators, four scourers, one screenings separator and scourer, and two magnetic separators. The elevator is provided with a passenger elevator, same as the mill. The warehouse is on the opposite side of mill from elevator and about 50 ft. distant, back of which is the cooper shop, where barrels in sufficient quantities to accommodate the requirements of the mill are made. The packers are located on the second floor, from which the finished products are discharged by means of ingeniously devised chutes either into the warehouse, cars, vessels or docks, as desired. One section of the mill is in operation at this time to its full capacity. The fact that orders were booked for over 25,000 barrels of flour before the mill had started bespeaks the great confidence entertained by large buyers for the management as well as the capabilities of this mill. No expense has been spared by the company to make this mill unequaled in every facility for the rapid and economical handling of grain and the finished products, to the end that the cost of manufacture of their goods might be reduced to the lowest possible limit, and in this they have been eminently successful. Nordyke & Marmon Co., Indianapolis, Ind., furnished the plans and built the mill complete.



THE NATIONAL MILLING CO.'S NEW MILL AT TOLEDO, OHIO.

CELLULOID FILMS.*

By J. DESIRE ENGLAND.

FOR many years past it has been a great aim in photography to substitute a lighter material than glass as a support for the sensitive film for negatives, and until the introduction of celluloid no substance was found to be capable of supplanting glass for the purpose.

Celluloid, a new material in the arts, dates back to about the year 1869. It is a hard, durable substance, almost entirely unaffected by acids and alkalies, unchangeable under ordinary atmospheric conditions, and is very tough. It is rendered plastic by heat, and can be moulded into any desired form. Alcohol and acetic acid act upon it, partially dissolving it. It is soluble in acetate of amyl, forming a useful, quick-drying varnish. It is manufactured in a variety of forms. Imitations of tortoise shell, amber, and malachite are produced which defy detection very often. The sheet imitation of ivory is used in photography as a basis for positives. The variety, however, which concerns us mostly now is the transparent kind, which is manufactured in sheets 1-100th of an inch in thickness, and which has a surface like glass. It is as clear, and, like glass, is not affected by moisture, which, of course, is a very great desideratum for our purpose.

The manufacture of celluloid sheets is somewhat as follows: A pile of pure white paper is acted upon by nitric and sulphuric acids, converting it into nitrocellulose. It is washed to free it from the acids, and then treated with wood spirit and camphor, producing a jelly-like block, which is then subjected to great pressure, which is sustained for several weeks. The block, from which most of the spirit is evaporated, is put into a machine something like a planing machine, and is cut into shavings of the thickness of the film required; each shaving or sheet of film, which measures 50 by 20 in., is hung up to dry for a period of about three months, in order to thoroughly season it and prevent any after-change. Each sheet is then taken and rolled under great pressure between heated metal plates, to obliterate the marks of the cutting knife. If one takes a piece of celluloid and moistens it with alcohol, one can see very distinctly the lines caused by the knife. The metal plates are either polished or grained, according to the surface required, the polished giving the smooth film and the grained the matt surface. Both kinds are used, but I certainly prefer the smooth. Some makers of negative films coat the matt film, leaving the matt surface at the back. It is no doubt very good for retouching, but the negatives take longer to print, and also the matt surface is very liable to become scratched. The gelatine emulsion is spread over the sheets by means of special appliances, which produces a film of gelatino-bromide of silver of great uniformity. The emulsion is the same as that used in the preparation of dry plates, and the film when dry is precisely the same as a glass plate, with the exception that the support is celluloid instead of glass. The great advantage of celluloid films is, of course, the lightness and portability; a dozen half-plate films weigh about 4 oz., while the same number of glass plates will average 3 lb., while in thickness one gross of films will occupy 4 in. and one gross of glass plates about 14 in. Another great advantage is that there is no fear of breakage. Halation, too, so common with glass plates, is almost entirely obviated by the use of films.

The films can be kept flat for exposure in the dark slide by several means. For small sizes a piece of dark card placed at the back will be found sufficient; this applies only to slides in which the rabbet is not cut away for the stop of the shutter, as in the slide I have here. The most useful contrivance, however, is this film carrier, which consists of a card with light metal grooves at the ends. They are very effective, light, and inexpensive. For very large sizes the plan adopted first, I believe, by Mr. Warnerke consists of sticking the films upon a surface which is always tacky. This method is a very good one, but care must be taken to keep dust from the surface. In my own practice I usually employ carriers which are curved. I find there is great advantage in using curved films when the full aperture of the lens is employed, as it very materially aids even definition. The exposure required is the same as that for glass plates. I have found that there is no difference whatever whether the emulsion is coated upon glass or celluloid.

For development any of the usual developers are suitable, and the films will lie flat, provided that the bottom of the dish is first wet. It is not necessary to wet the film previous to development, except for larger sizes. They are fixed in the same manner as glass plates, but care must be taken that the edges do not curl up out of the solution and thereby escape fixing. The films when fixed are well washed, and then hung by one corner to dry. I find the small clips used for fastening neckties useful for drying. Several clips can be threaded on a line and several films dried at a time. The negatives can be reduced or intensified without difficulty by any of the well known formulæ, and easily be varnished by means of a varnish which does not require heat in drying, such as amber in chloroform. Celluloid varnish may be used. These varnishes are best applied by means of a brush. A very good varnish may be made by thinning gold size with benzole, but it takes rather a long time to dry. A plan, however, which I have lately tried, and which seems to be simple, and at the same time very effective, is to dip the film after washing and before drying into a water varnish consisting of pale shellac dissolved in an aqueous solution of borax. This dries with a very hard, impervious coating.

There are many useful applications to which celluloid may be applied. In Moessard's cylindrograph, which takes panoramic pictures two or three feet in length, the films are inserted in a slide which is bent to form the segment of a circle. Another useful application is in making stereoscopic pictures. The stereoscopic negatives can be cut with a pair of scissors, and the halves transposed and mounted upon glass, when the prints taken will not then require reversing. Very good cloud negatives can be made with the films, which

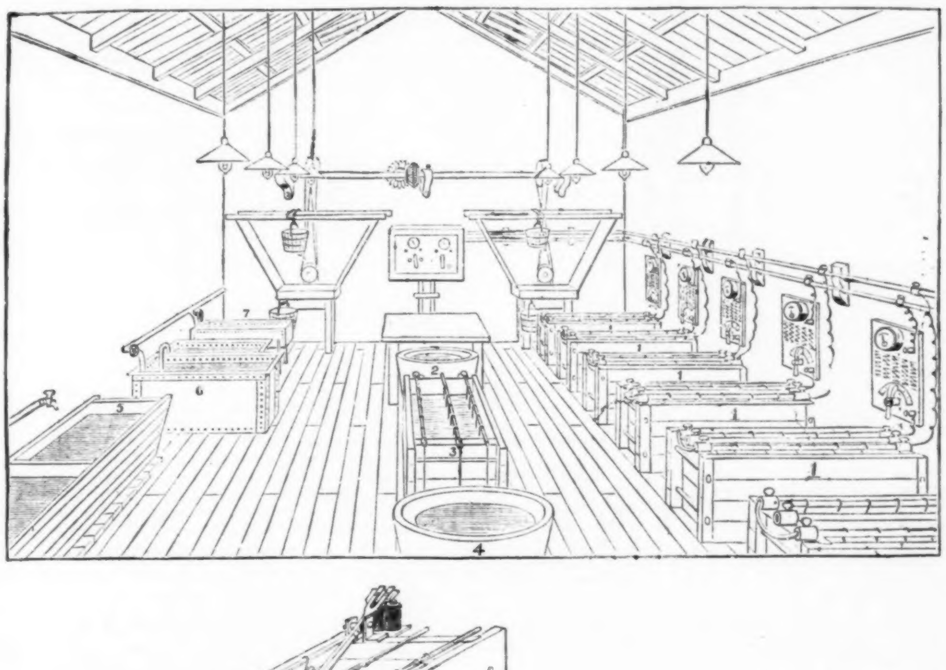
* Read before the West London Photographic Society.—*Amateur Photographer.*

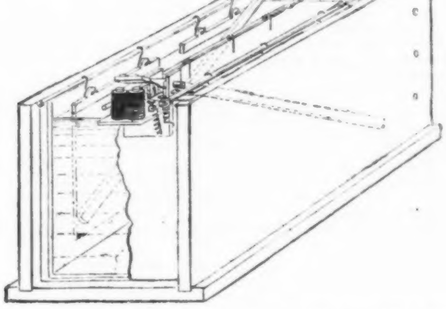
can be printed from either side. In cases where reversed negatives are required for carbon printing or collotype, a celluloid negative will be useful, and although one does not get absolute sharpness by printing in the ordinary manner, it can be much improved by placing the frame containing the negative at the bottom of a box, so as to cut off all the oblique rays of light. By this means one can get sharp pictures. For focusing screens, too, the matt celluloid forms an excellent substitute for the ground glass.

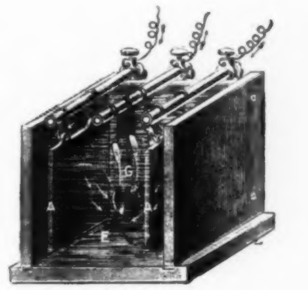
I should like to give a word of caution as to storage of negative films. They should be kept, like plates, in a dry place, away from gas fumes, and above all, the films should not be subjected to too much pressure. On account of their being unbreakable, one is very apt in traveling to pile a great many things upon them, and this is often the cause of peculiar insensitive markings upon the negative. Captain Abney has pointed out that the effect of pressure upon a gelatino-bromide film is to destroy sensitiveness in the parts pressed. In conclusion, I hope the few hints I have given will prove of service during the coming season, when no doubt celluloid films will be very extensively used.

AN ELECTRO-PLATING PLANT.

THE London Metallurgical Company (limited) make a specialty of electro-plating in which their patent "Areas" metal, which is an alloy largely consisting of silver, is alone employed. The advantages claimed for







AN ELECTRO-PLATING PLANT.

it over silver and nickel plate are mainly that (1) it is not readily discolorable when subjected to tarnishing influences and not easily affected by acids; (2) it may be deposited to any required thickness in an adhesive form impervious to moisture; (3) it is more elastic than nickel, though nearly as hard; (4) any given thickness of "Areas" plating lasts much longer than an equal thickness of silver plating, because it requires no polishing powder to clean it; and finally (5) it is harder as well as cheaper than silver, while closely allied to that metal in appearance. A great drawback to silver plating is the difficulty experienced in keeping it bright, owing to the fact that, when exposed to an atmosphere containing even a trace of sulphur (which is always found in the air of towns), the sulphur combines with the silver and forms a sulphide of silver, which has to be removed by means of a polishing powder before the silver can be restored to its natural brightness, resulting in rapid destruction of the silver plate. Silver, electro-deposited, has often the disadvantage of being comparatively soft, and is soon worn off the prominent parts of the coated article, the baser metal thus becoming exposed. Nickel plating, although cheaper, has a more limited field than silver plating, because, among other reasons, it is unsuited for some kinds of goods. Moreover, it cannot be deposited to any required thickness, and is liable to crack and peel off on account of its great hardness and brittleness. Nickel plating may be porous, too, allowing moisture to penetrate to the baser metal, so that it is held to be of little use for protecting iron and steel, and in point of color it is always inferior to silver. "Areas" plating is said to have none of these drawbacks, and may be employed for electrical fittings, chandeliers, yacht fittings, surgical and dentistic instruments, cycles, lamps and reflectors, and the multifarious uses to which electro-plating may be devoted. The process is similar to that employed for silver and nickel electro-plating, the improvements consisting in the metal and chemicals used. The articles, after having been cleansed from dirt and grease, are placed in a slate or lead lined tank, as shown in our illustration. An electric current is then caused to flow from a battery or dynamo through the anodes, which are made of "Areas" alloy, to the cathodes, which consist of the articles to be coated. The current passing through the electrolyte decomposes the metal it holds in solution and causes it to be precipitated on the cathodes, the "Areas" plates being attacked and dissolved by the chemical constituents thus set free. The thickness of the coating is proportional to the duration of the process. The electric agitator, of which we furnish a sketch, is an ingenious contrivance for keeping the electrolyte in motion when plating with dense or cold solutions. Ordinarily the effect is produced by mechanical means, necessitating the employment of shafting and belting, which in the event of the vats not being in line becomes very expensive. Blowing air through the solutions or using circulating pumps are both methods to which objection must be taken, as involving considerable expense. Under the Areas system electricity itself provides the power. An arm is drawn up quickly by means of magnets and allowed to fall gradually by its own weight. This motion entirely overcomes any tendency in the electrolyte to form layers of different density and, as a consequence, of uneven plating, and yet the action is not so violent as to stir up the sediment at the bottom of the vat. Another advantage of the new form of agitator is that it can be left working through the night by a battery or accumulator.—*Ironmonger.*

ELECTRICITY IN A MODERN RESIDENCE.

By H. WARD LEONARD.

USES.

THE uses of electricity in a residence may be treated under the following heads:

1. Electric lighting.
2. Electric power.
3. Electric heating.
4. Electric bells, annunciators, etc.

ELECTRIC LIGHTING.

The incandescent lamp is without dangerous heat, is free from odor, absolutely clean, and is controllable at the lamp or from a distant point if desired. Hence, the lamps may be placed anywhere desired, and we are not limited, as with gas, to a rigid fixture placed in the midst of a large space and with the lights all necessarily pointed upward.

The lamps can readily be placed upon the ceiling or walls, or in recesses made in them for the purpose. The fixtures can be made of any conceivable design, and lamps of any candle power and color be placed in any position upon them.

In lighting a residence, we should dismiss from our minds all preconceived notions based upon the use of gas and oil.

Where do we want light? How much? Of what character? and where controlled from? Make such a specification and give it to a concern experienced in such electrical construction work, and the desired result will be obtained in every case.

If we have outside lights, they will be unaffected by the weather, and controlled from just inside the door. Lights in a stable will be controlled either from the house or stable at will. Lights in a cellar or dark basement will be controlled by a switch placed at the entrance, so that the lamps will be lighted before we enter, and extinguished when we have left.

Every bed room, closet, store room, etc., will be lighted by a lamp which lights up automatically as we open the door, and is extinguished when the door is closed. The convenience of this device can only be appreciated by those who have had experience with it. In many places in the house we will have a lamp which can be operated either at full candle power or at a very much reduced candle power at will.

In the parlors we will have all the beautiful effects produced by piano lamps, banquet lamps and fairy lamps, without any of the present accompanying care, danger, heat and disagreeable odor.

Every room will have a switch placed beside the doorway, so that the lamps can be most conveniently controlled by a person entering or leaving the room.

In such a house the most timid child, of but a few years, will go anywhere with safety and without fear, lighting and extinguishing the lamps as desired.

The lamp bulbs will be clear, frosted, colored or opalescent, as occasion requires. We will have, in every place desired, the softest, steadiest and coolest light obtainable.

The most beautiful effects can be obtained in the dining room and upon the dinner table. Electric candelabra can, if desired, be used which will be identical in appearance with those using candles.

Pictures can be lighted in a manner entirely impossible with gas.

The most delicate and beautiful colors in paintings and decorations retain indefinitely their original beauty, since the bleaching and blackening effects of gas are entirely absent.

It is probably but little appreciated, but entirely true, that the greatest expense due to the use of gas in a handsome residence is the depreciation it effects upon the costly materials in the residence, rather than the bill for the gas itself.

A few years ago there was a probability that the wiring of a residence would, in the future, fail or prove unsuited to the system of lighting which it would be desired to use. This condition of affairs does not now exist. The commercial systems of electric lighting have become as fixed, as regards the interior wiring, as have the gas systems; and to-day it is possible to wire a building for electric lamps with a much greater certainty that the result will be permanent, satisfactory and suited to future use than is possible in the case of gas piping.

If the building is not to be lighted for some time, it should be equipped with a system of insulating electric conduits which make it possible to draw in any wires desired at any time in the future, or to replace wires previously drawn in.

COST.

The first cost of wiring varies widely. An average figure will be about two dollars and a half a lamp; but in some instances it will be as low as one dollar and a half per lamp, and in others as high as four dollars per lamp. It will rarely exceed these figures when a residence is wired throughout.

The charge for current is, for the same result, about the same as gas. The current used can be accurately recorded by an electric meter; hence, the bill will be exactly proportional to the consumption of current.

ELECTRIC POWER.

The most conspicuous and important application of electricity for power purposes in a residence is for operating an elevator. It is possible to-day to have in a residence an electric elevator which is reliable, simple, safe, convenient and economical to operate.

There is no engine, pump, tanks, pipes, valves and the multiplicity of devices which are required for the steam or hydraulic elevator.

There is no noise, heat nor smell accompanying its use, and it is always ready to operate, and can be operated with perfect safety by a child.

There is no hand rope, the control being effected by the movement of a small electric switch in the elevator car itself.

The motion of the elevator is perfectly smooth, and it can be made to go at any speed in either direction. It is automatically stopped at the top and bottom floors, and no accident can occur, even though the electric supply should fail entirely.

An elevator boy is unnecessary, as the elevator can be controlled from any floor and brought to the desired floor, when the elevator door can be opened, but not until then. While the elevator door is open it is impossible to operate the elevator from any of the floors, so that there is no danger of any movement of the elevator while a person is getting in or out of it.

The first cost of such an elevator will be from $2,000 to $3,000. The expense for the current for operating it will, in ordinary instances, not exceed $5 per month, and the cost of maintenance will be but a few dollars per year, as it is entirely simple, and requires almost no attention.

No greater luxury than a passenger elevator can be placed in a residence; and it has been only very recently that such a luxury could be provided; for in the case of a hydraulic elevator, the water for which was pumped to a tank above by means of a steam engine, gas engine or electric motor, the complication and expense of attention and maintenance were practically prohibitory, and the unreliability very annoying.

Many complex methods of operating directly by an electric motor have hitherto been attempted, and many are still upon the market; but in order that an elevator shall be worth having in a residence, it must be entirely free from complex apparatus and must be always reliable, simple and smooth in its operation; and it has been only very recently that a direct method of operation has been developed which is free from the complication of rheostats, brakes, solenoids, etc., which have characterized the electric elevators heretofore, and rendered them uncommercial except in expert hands.

Other applications of power in a residence are the operation of dumb waiters, small ventilating fans, ice cream freezers, the pumping of water, etc.

The dumb waiter will need a motor of perhaps ¼

horse power, costing, with its gearing, perhaps $150. A small electric ventilating fan will cost about $25 complete. An ice cream freezer will require a quarter or half horse power motor, and will cost complete from $100 to $200. An automatic electric pump will cost about $200.

The expense of operating all of these convenient devices will probably not exceed $50 per year, even when used a great deal.

ELECTRIC HEATING.

Heating by electricity is, generally speaking, the most extravagant luxury obtainable from its use. Hence the heating of large spaces continuously would be out of the question, except where power has but little value.

But when we wish a perfectly controlled, safe, instantaneous heat for occasional use, we can obtain it readily, conveniently and economically by the electric current.

For instance, electric flat irons can be operated in a most satisfactory manner by making connection in any incandescent lamp socket. The flat iron, in a few seconds, reaches a sufficient, but not scorching, heat, and remains at this heat continuously. The cost of the flat iron is but a few dollars, and the cost of operating about five cents per hour.

Various cooking operations, such as boiling eggs, making coffee, cooking batter cakes, etc., can be performed in a most perfect and convenient manner, and the development of the uses of electric heating for cooking operations will be very rapid in the immediate future.

ELECTRIC BELLS, ETC.

With the introduction of the incandescent light into a residence the nuisance of inoperative electric bells ceases. Having a constant source of electric supply, we are no longer at the mercy of the battery which has "run-down," nor will we need the high-priced services of the so-called electrician, who has been with us so much in the past.

In a residence having incandescent lamps, our electric bells, annunciators, etc., will be always perfectly reliable, and will require no attention whatever for an indefinite period.

COUNTRY RESIDENCES.

A few residences in this country are supplied with individual electric plants. But, aside from the first cost, the care and expense of maintenance has made such instances very rare.

It is now possible to utilize a windmill for an isolated residence plant, so that in an extremely simple manner the windmill will produce electricity for lighting, operating an elevator, chopping feed, sawing wood, etc., etc.

A small storage battery is used to provide means of keeping up the service when there is no wind.

The great difficulty has heretofore been to govern the windmill, and many unsuccessful attempts have been made in this line.

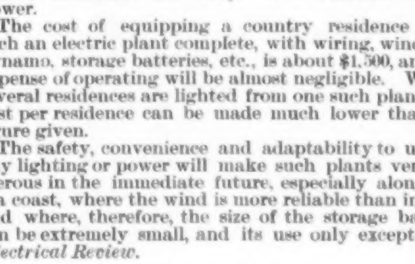
The present and successful method, however, makes no attempt to govern the windmill; but in a very simple manner provides means so that, whether the windmill goes fast or slow, the dynamo for the incandescent lamps is operated at a constant speed; and hence, maintains the lamps at a constant candle power.

The cost of equipping a country residence with such an electric plant complete, with wiring, windmill, dynamo, storage batteries, etc., is about $1,500, and the expense of operating will be almost negligible. Where several residences are lighted from one such plant, the cost per residence can be made much lower than the figure given.

The safety, convenience and adaptability to use for any lighting or power will make such plants very numerous in the immediate future, especially along the sea coast, where the wind is more reliable than inland, and where, therefore, the size of the storage battery can be extremely small, and its use only exceptional.—*Electrical Review.*

IMPROVED ELECTRIC HEAT ALARM.

THE little device here shown is for use in connection with journals and other parts of machines where injury is liable to be occasioned by overheating through



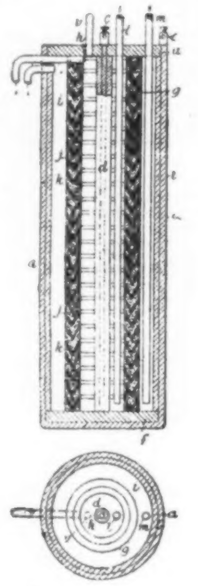
ELECTRIC HEAT ALARM.

friction or other causes. It is designed to give an alarm automatically when the heat begins to be excessive. The most essential portion of the device consists of a metallic cylinder made up of two sections. The lower section, which is closed and solid at one end and open at the other, is provided with an inside thread at the open end. The upper section is fitted with a shoulder and outside thread, so as to screw into the first section as a plug, forming one cylinder. Extending from this shoulder is a projection shaped like the frustum of a cone, of such length that when the two sections are screwed together it reaches very nearly to the bottom of the lower section. A small hole through this projection connects the hollow parts of the two sections. Within the upper section a hard rubber non-conducting plug is screwed. Through this last named part a metal spindle passes, connecting at its outer end with one of the poles of an electric battery. The other battery connection is the set screw in the upper section. A nut holds the spindle in position.

For operation the first section is partly filled with mercury, the two sections screwed together, and the device is then fixed to the journal box. Excessive heat causes expansion of the mercury, and forces it through the hole connecting the two sections, bringing it into contact with the spindle, thus completing the circuit and giving an alarm by means of an electric bell. The alarm was designed by Morril S. Pierce.

THE ELECTRIC PROCESS FOR MANUFACTURING CHLORINE AND CAUSTIC SODA.

EACH of the elements of Greenwood's electrolyzer consists (Figs. 1 and 2) of an iron cylinder, *a*, which serves as cathode, and is connected at *c* to the negative



FIGS. 1 AND 2.

pole of a dynamo; of an anode, *d*, of metal-coated carbon, connected at *e* to the positive pole, and insulated from the cathode by a piece of slate, *f*; and finally of a porous partition, *g*, which divides the element into two parts, *i*, for the soda; *h*, for the chlorine. This partition is formed by piling on top of each other a number of beveled circular troughs of glass, porcelain, or slate, filled with a porous matter resisting the action of chlorine, such as asbestos or powdered steatite; it prevents the chlorine given off at *h* from getting access to the soda, which latter is separated at *i* from the electrolyzed sodium chloride.

The two compartments, *i* and *h*, are originally filled with a solution of sodium chloride from the bottom, by means of the tubes, *l* and *m*, fed separately from the reservoirs, *o* and *p* (Fig. 3). The solution circulates rapidly from the bottom to the top, so as to reduce

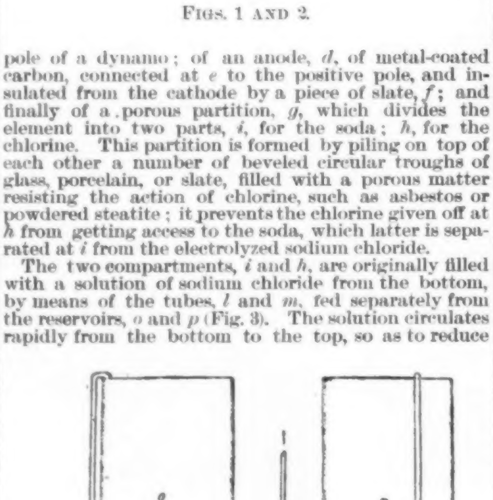


FIG. 3.

polarization to a minimum; the chlorine is given off at *h* and the soda at *i*. The electrolyzed solution is pumped back from the reservoirs, *q* and *r*, by the pumps, *s* and *t*, into the feeders, *o* and *p*, until it is sufficiently decomposed, and *p* is filled with a solution of caustic soda and a little common salt, which are subsequently separated by evaporation. The chlorine escapes through the porcelain covers, *u*, by means of enameled iron pipes, *v v*.

The cylindrical elements of the apparatus can be replaced, as shown in Figs. 4 and 5, by rectangular elements with iron cathodes, *a*, metal-coated carbon, *d*, and porous partitions, *g*. The solutions circulate as before through the tubes, *l m*, to the compartments, *h* and *i*, containing the soda and the chlorine.

The anodes of metal-coated carbon are prepared by copper-plating and afterward tin-plating small plates of retort carbon placed in a frame, so as to form one large plate hollowed out in the center, and formed into a compact mass, by pouring melted type metal into the center. This type metal may contain copper strips so as solidly to bind together the constituent parts of

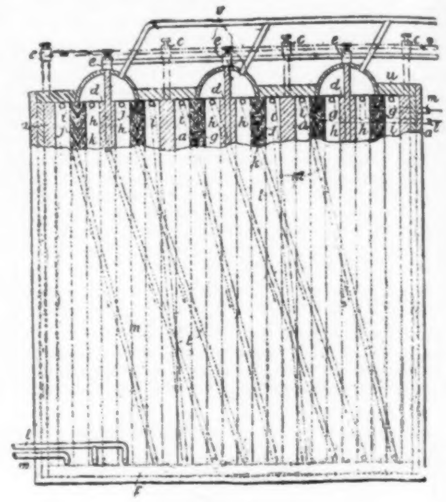


FIG. 4.

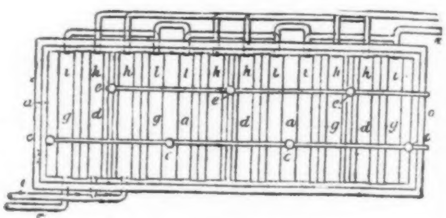


FIG. 5.

the plates, and the carbons must be made impermeable to the electrolyte by saturating them with paraffin.

By this process, which is now being experimentally used by the *Chlorine and Caustic Soda Syndicate*, London, it is said one ton of common salt can, according to Mr. Preece, be decomposed at the cost of sixty-eight shillings, and caustic soda and chlorine produced at about one-third their present market price.

NOTE ON THE CONDUCTIVITY OF PEROXIDE OF LEAD.

By JOHN SHIELDS, Ph.D., B.Sc.

WHEN a solution of sodium lead tartrate is electrolyzed, hydrated peroxide of lead separates out on the positive electrode. The formula ascribed to this peroxide by Wernicke and Streintz is H_2PbO_3, and a sample which I analyzed contained:

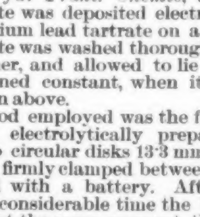
	Found.	Theory.
PbO_2	3·46	93·0
H_2O	6·54	7·0
	100·00	100·00

which corresponds sufficiently well with the theory.

In order to decide whether peroxide of lead and its hydrate conduct electricity like the metals or like electrolytes, pure peroxide was prepared by Wohler's method (*Journ. fur Prakt. Chemie*, vol. xc., p. 383), while the hydrate was deposited electrolytically from a solution of sodium lead tartrate on a sheet of platinum. The hydrate was washed thoroughly with water, alcohol, and ether, and allowed to lie in the air until its weight remained constant, when it possessed the composition given above.

The first method employed was the following. The chemically and electrolytically prepared peroxides were pressed into circular disks 13·3 mm. in diameter, which were then firmly clamped between two platinum plates connected with a battery. After the current had passed for a considerable time the battery circuit was broken and at the same moment the plates were placed in connection with a sensitive galvanometer. Although the experiments were repeated several times, no deflection of the galvanometer could be observed. Now, if either of the peroxides conducted electrolytically, decomposition would have ensued on passing the current of electricity, and consequently a polarization current would have been obtained on breaking the battery circuit and connecting with the galvanometer. As neither of the peroxides gave such a current, we must conclude that both conduct electricity metallically.

The result stands in direct opposition to that of



Streintz (*Wied. Ann.*, xli., 104), who found that chemically prepared peroxide of lead conducted like a metal, while the hydrated peroxide behaved like an electrolyte. I therefore determined to repeat the experiments, using another method, namely, that employed by Streintz. Fig. 1 is a diagram of the arrangement. A glass tube, A, is closed at one end with a piece of clean metallic lead or platinum as the case may be, and into

the tube is pressed the substance to be examined. This is connected with dilute sulphuric acid contained in the beaker, B, by means of a moist cotton thread. In the beaker stands a rod of amalgamated zinc. The difference of potential between the zinc and the lead or platinum is measured with the electrometer, E (in this case Ostwald's form of the capillary electrometer was used, and the potential difference obtained by compensation).

Now, if the substance contained in A conducts like a metal, we may replace the lead by platinum or any other metal, and the potential difference will always remain the same. On the other hand, if the substance in A is an electrolyte, we will obtain a certain difference of potential between zinc and lead, and if we substitute platinum for lead we will obtain another potential difference, and so on for all the different metals.

I found it convenient to prepare several tubes, half of which were closed at one end with freshly scraped lead and the other half with platinum. The following results were obtained:

Chemically Prepared Peroxide of Lead.

Potential difference	Zn—Pb	2·13 volts.
" "	Zn—Pt	2·14 "

Electrolytically Prepared Peroxide of Lead (Hydrate).

I.

Potential difference	Zn—Pb	2·01 volts.
" "	Zn—Pt	2·02 "

This sample was thoroughly washed with distilled water and dried in the air.

These experiments confirm the result obtained by the first method, and as this does not agree with the observations of Streintz, a fresh quantity of peroxide was prepared electrolytically; it was washed with water, alcohol, and ether, and then *at once* pressed into the tubes and the measurements made.

Electrolytically Prepared Peroxide of Lead (Hydrate).

II.

Potential difference	Zn—Pb	1·92 volts.
" "	Zn—Pt	1·94 "

The potential differences observed are in all cases independent of the metal in direct contact with the substance examined, and therefore we must conclude that *peroxide of lead, PbO_2, as well as its hydrate, H_2PbO_3, conduct electricity in the same way as the metals.*

Opportunity was also taken to make an approximate determination of the resistance of the peroxide of lead, and no change in this was noticed on heating to 115° C.

	C.G.S. Units.
Specific resistance of the chemically prepared peroxide	$5·59 \times 10^9$
Specific resistance of the electrolytically prepared peroxide	$6·78 \times 10^9$

Leipzig, December, 1891. —*Chem. News.*

NIKOLA TESLA.

IT was not to be expected that in the short evening at his disposal, and with such a host of experiments to be performed, Mr. Nikola Tesla could do more than indicate, merely, the kind of way in which the remarkable results of his untiring labors were obtained. So various were the phenomena, that even the lecturer was from time to time in doubt as to the best way of presenting the delectable feast to his guests; and so incomprehensible were the effects that he confessed, "I cannot see the forest on account of the trees."

Already the work of Mr. Tesla, with regard to currents of high frequency and high potential, had been received and appreciated in this country, as far as printed descriptions could make it plain to us. But something more was needed to impress us with the true sense of its importance. We wanted to see the phenomena themselves, and to have before us the man who had deciphered them from nature's infinite book of mysteries.

The lecture given before the electrical engineers at the Royal Institution, Feb. 10, was only the second which Mr. Tesla had ever given in public. At the invitation of the managers of the Royal Institution, the lecture was repeated the next day to its own members. There were large and distinguished audiences upon both occasions, which were enlivened, on Feb. 11 especially, by the presence of ladies.

The first lecture which Mr. Tesla delivered on the subject of high frequencies and high potentials was given before the American Institute of Electrical Engineers, at Columbia College, N. Y., in May, 1891. It is reported upon in our columns for July and August of that year.

With researches on high rates of discharge we naturally connect the names of such men as Crookes, Rayleigh, Spottiswoode, and De la Rue. It would appear, also, that Mr. Rankin Kennedy had already demonstrated the possibility of lighting by the means which Mr. Tesla has followed, when, in 1882, Mr. Kennedy patented (No. 4,752) a method for "Intensifying fluorescent and phosphorescent electric lighting, whereby the same is rendered serviceable for illuminating purposes, and apparatus for effecting the said intensification."

Throughout his lectures, Mr. Tesla has shown a deep sense of his appreciation for those who have been before him in the field, and everywhere he has specially acknowledged his indebtedness to Mr. Crookes, whose fascinating little book he declares gave him the initiative to labor in the direction of electrical discharge. To all who would claim priority in this or any research, we recommend a careful reading of the eloquent little speech with which Mr. Tesla replied to the vote of thanks on Feb. 11 at the Royal Institution. For this purpose we have printed it in our columns.

Mr. Tesla has many more things in view than those he introduced to us recently. Not a third of the experiments he had prepared were actually shown, on account of the limits of time. It will be well, therefore, to reserve any criticism or discussion of the results until Mr. Tesla has had the opportunity of describing them in detail; this, we believe, he intends to do through the press at an early date.

It may be observed that the high frequency and high potential are obtained from an induction coil of a special form, and receiving in its primary a special oscillatory current. Mr. Tesla sends the current from an alternating dynamo into the primary of a transformer, the secondary being connected through a magnetostatic interrupter to two brass knobs, between which a series of discharges takes place. From these knobs are taken leads to the primary terminals of an induction coil, not directly, however, but through a capacity formed by Leyden jars. It is thus seen that when a spark occurs at the brass knobs, an oscillatory discharge surges through the added capacity and the primary of the induction coil. The rate of these oscillations is about one million per second. The effect of the passage of this current, through the primary, is to produce at the secondary terminals a current, not only of high frequency, but of high potential.

When phenomena such as those developed by Mr. Tesla are brought before us, it is usual to seek out, on the principle of reversibility, the complementary set of facts, advancing from where they stop, to find a return path with new beauties. In this case the result of such a line of thought leads us to the endeavors of Becquerel and Minchin to obtain currents and E.M.Fs. from electrodes, when acted upon by solar rays. In the *Philosophical Magazine* for March, 1891, Professor Minchin writes: "It is conceivable that a photo-electric battery may yet be found which will simply act as a transformer of the energy it receives from the sun, while its own materials, being merely the implements used in the process, may be almost wholly unmodified."

The latest experiments with photo-electric cells have established the remarkable fact that when a suitable capacity is connected to them, they can be changed from an insensitive to a sensitive state by the action of a Hertz oscillator at a distance of many feet. How is this? Another analogy lies in the fact that of the liquids used in connection with the original experiments with silver plates, those which were fluorescent, such as eosine, sulphate of quinine, and fluoresceine, seemed to suggest a connection between fluorescence and the electrical effect. It would be a revelation, indeed, if the light of Mr. Tesla's experiments could be found to illuminate the mysteries of those of Professor Minchin, and *vice versa.*

The idea of using electric lamps, without the intervention of leads, will remind some of our readers of the extraordinary telephonic experiments of Professor Dolbear, when he delighted his audience by removing the wires connected to his receiver, and fixing the instrument some yards away from the terminals, invited those that had ears, to hear. There is, of course, a great distinction to be drawn between these results and those of Mr. Tesla. The nature of the undulations in the two cases is probably widely different.

If to the genius and imaginative mind of Mr. Tesla the number and complexity of ideas revealed by his experiments are so great that he owns himself lost in them as in a forest of thoughts, to others the darkness must be deeper still. Yet, though we cannot even see the trees, we are grateful to our distinguished visitor for cutting us a little path, leading us a little way, and refreshing us with his great enthusiasm.—*The Electrical Review, London.*

OPEN-HEARTH STEEL CASTINGS.

By Mr. J. A. HERRICK, M.E., New York City.

THE object of this article is to deal in a general way with the most recent machinery and its arrangement as used with the open-hearth system for making steel castings. The first open-hearth castings produced in the United States regarding which the writer has any knowledge were made in 1872. These castings were satisfactory and went into active service, but owing to the difficulties and high cost of manufacture and the limited uses at that time of steel castings, their manufacture was discontinued, and the plant was used entirely for ingot steel. Since that time the peculiar adaptability of open-hearth steel for all sorts of steel castings has received more and more attention. Furnaces, processes, moulds, etc., have been steadily improved until now—after twenty years—some of the most magnificent plants in the world are largely devoted to open-hearth casting purposes, and the product is more and more used every year for railroad, structural, general machinery, and naval purposes. It is true that uniform excellence has not yet been attained, and many of the minor details still remain to be fully solved. But the open-hearth steel casting industry has made such rapid strides in recent years, and has attained such respectable proportions, that it must be conceded that it has passed the "experimental stage." Those pushing it have every reason to be proud of the achievements already attained, and to be most sanguine of the results to be still further secured. In no other line of work has individual energy and skill found greater scope, or capital been better rewarded. Until within some eight to ten years ago most of the substantial progress had been made abroad, particularly in England and France, where the demand has created the industry. In England the furnaces and machinery have been largely perfected, while in France the mixtures of steel and the alloys for solidifying and purifying such mixtures have received the most attention. The English have also been most fortunate in having a cheap supply of the best refractories, the ganister there being composed of pure silica, with just enough of other oxides to make a natural binder. Artificial binders are not needed, and any liability to form gases in the moulds from such combustible binders is almost entirely obviated; hence the progress of the art in England has been most rapid, until at the present time large and well equipped open-hearth steel casting shops are to be found in almost every important steel works in England and also to almost as great an extent on the Continent.

The rapid extension of the system in the United States only commenced about eight to ten years ago. The progress made in these last few years has been rapid and most gratifying. The efficiency of many of the older plants has been notably increased by the addition of these new furnaces. The continued erection and successful operation of new plants using these furnaces also bear witness to its ability to fill a long-felt want. Grave difficulties caused by the lack of natural supplies have been overcome here. We are now, therefore, fully abreast in our line of refractory materials of all sorts and proper stock and mixtures. The same may be said with reference to this line of furnaces and their appliances, and the general labor-saving arrangements needed for commercial success. While this system, when properly worked, furnishes steel castings which leave nothing to be desired, still considerable remains to be learned regarding the working out of its details. Judging the future by the past, one may confidently predict that these incidental difficulties will be readily overcome. Properly melted metal and suitable moulds are the essentials for making perfect castings. The furnace itself is one of the most important features, and must have sufficient power to properly melt and completely amalgamate the entire charge. The furnace must be arranged so that it can be readily handled and the degree and character of the heat changed at will. Cold metal means poor castings. A furnace perfectly adapted for ingot making is often wholly unable to turn out sound low-carbon castings.

One difficulty experienced by most parties on first experimenting with the open-hearth system is the apparent undue amount of shrinkage of the metal in the moulds. This can be practically overcome by the use of the proper precautions in making the melt and in handling the moulds. The open-hearth is the best system yet devised for making *bona fide* steel castings, and can also be recommended for its marked economy. No fancy or expensive stock is required. Ordinary low-priced stock by this system is capable of producing metal of the highest degree of excellence. In proof of this the fact may be cited that the furnaces erected by the writer are now regularly making soft metal, testing from 58,000 to 67,000 lb. T. S., and from 15 to 24½ per cent. elongation, according to temper and quality, the tests having been made under government inspection. One very important advantage results from the fact that these castings need no annealing for ordinary uses, and are only so treated for special government work. Hence a great economy of time is also effected. Reference is now made to the plan mentioned above. Great latitude is allowable in the choice of the construction and material adopted in such a structure. The cheapest method is to erect a balloon frame of wood, the same being covered with corrugated sheet iron, suitable ventilation being provided at the roof. The building must be strengthened proportionately if an overhead crane is to be used. If the building is made of brick and iron, or of iron alone, the expense will necessarily be largely increased. The most convenient dimensions are about 60 ft. in width by 200 ft. in length and 30 ft. in height, clear of the trusses. The length and height may be increased if needful. An annex extends along one entire side of the main building. A similar wing covers the ovens on the opposite side, while a small building at the extreme corner of the main building accommodates the gas producers.

The principal feature of the plant is the open-hearth furnace. This is of 10 to 12 tons capacity, and is centrally located at one end of the main building. The charging floor is some 7 ft. above the foundry level, and is about 40 ft. by 25 ft., and is formed of cast or wrought iron plates carried by suitable columns and beams. Upon one corner of this floor a small testing laboratory is arranged. At the opposite corner is located a suitable hoist for elevating the materials for charging the furnace and also the coal for the producers. A platform scale is located directly in front of the hoist on the lower floor. A bridge, 12 ft. above the ground level, connects the hoist with the coal platform of the producers. In larger plants a railroad siding delivers the coal directly upon the producer floor, but here it is not really needed. Two-pound Herrick producers furnish the gas for the plant and deliver into an overhead lined gas tube, which in turn is connected with the gas valve of the furnace. A flue below the furnace bed furnishes the gas for the ladle. This is heated by a blowpipe flame of gas and air, the air being driven by a small fan. The tapping platform is directly in front of the furnace, and on each side of the spout. The ladle, which hangs from a suitable crane, receives the molten metal and delivers it to the moulds, which, with a jib crane, are arranged in circles. A jib crane is the best where many moulds are used. It works the fastest, both in setting and knocking out the flasks, and the metal can be poured more quickly into a large number of moulds. The jib crane is of twenty tons capacity, hoists and lowers and also trolleys by power, furnished by steam engines, directly attached to the crane. Revolving the crane by hand is preferable for this class of work. A plain 12 ton traveling crane may very conveniently be used in connection with the jib crane, the latter swinging under it. A 10 and a 5 ton jib crane can be used together if desired, to replace the 12 ton traveling crane.

For drying the moulds and cores three ovens of improved construction are used. They are provided with tracks, front and back doors, and with fireplaces—one stack serving two ovens. For ordinary work these ovens are made about 40 ft. long, 15 ft. wide, and 8 ft. high. A pit track, in front of the ovens, is used when the jib cranes replace the traveler. A pit furnace is used for annealing large castings. The moulding floor annex contains a cupola and adjuncts, which can be used for making the cast iron flasks needed for open hearth moulds. The annealers, heating furnace, etc., are useful for special work, to straighten and finish castings when needful, but their use is not imperative for any ordinary plant. A railroad track connects with the main floor, and a suitable crane serves both annealers. The chipping shop, where the castings are finally prepared for shipment, is at the opposite end of the annex. A railroad track and turntable connect this shop with the other parts of the foundry and the shipping department. A small overhead crane runs the entire length and serves the necessary machine tools and saws. In order to utilize the 20 ton crane to the utmost advantage a movable track is added, so that the empty flasks and the sand, after pouring, can be rapidly removed, and the space again filled with new moulds. The railroad system allows the burnt sand to be easily removed to the opposite end of the main floor, where it is renovated and prepared for further use.

Attention is now invited to a few of the salient features of the open-hearth furnaces as described in this article. The simplicity of design and the cost of construction is reduced to a minimum. These furnaces

have run from fifteen to eighteen months single turn, twelve months double turn, with practically no repairs. A 15 ton furnace has actually produced nearly 12,000 tons of ingots without rebuilding. The artificial gas used is as easily controlled as if operated by natural gas. This result is obtained by the use of a device upon the charging platform, under the control of the melter. All inexperience or willful negligence on the part of the producer men is thus eliminated. By improved regenerators, together with the above device and certain new reversing valves, an economy of 25 per cent. in time of melting and cost of fuel over the older systems is effected. A great degree of uniformity in the chemical character of the steel produced is regularly obtained. Less waste of materials from any excessive oxidation in the bath is insured from the fact that a true chemical flame and great rapidity of melting is secured. And a further appreciable economy is thus also effected, because smaller amounts of manganiferous or other alloys need to be finally added to the melt.—*Iron Age.*

OYSTER CULTURE AT ARCACHON, FRANCE.

ARCACHON as a summer, and especially as a winter, health resort is so well known to every one that it is not necessary for us to eulogize it. Its products, envied by good livers, are equally well known. But what we believe to be pretty generally unknown is the method of cultivating the valuable mollusk called the oyster. Without delivering a course of lectures on ostrei-culture, which would not come within the scope of our journal, we propose to try to interest our readers by initiating them into the method of culture of this interesting shellfish.

The basin of Arcachon, the water of which is more saline than that of the ocean, has, from very remote times, furnished natural beds of oysters, but the artificial culture of the latter did not begin and was not subjected to regulations till along about 1850. Since then, the modifications and improvements have regularly followed an ascending course, until now an export production is attained that is sufficiently lucrative for the greater part of the inhabitants of the basin.

The basin of Arcachon, which is about 48 miles in extent, in communication with the ocean, is formed of immense banks of sand, which are separated by numerous deep channels whose swift currents are sometimes quite dangerous. It is upon these banks, which are bare at low tide, that the parks are installed.

The tourist who arrives at Arcachon for the first time at the moment of high tide has no idea of the extensive works that lie under this immense sheet of water, and might seek the site of the parks in vain. These latter, submerged for a few hours, gradually emerge and expose their hedges of slender pines with waving green tufts, and their banks of fine sand gilded by the bright sun, and which are afterward dotted by hundreds of laborers, who swarm over their surface.

Let us follow the very interesting work of forming a park. In the first place, there are formed various basins of rectangular shape called *claires* (separated from each other by sluices), of an average size of 160 by 90 feet, surrounded by a solid dike of clay. These dikes are usually 12 inches in height by 20 in width. In order to render them more solid, they are surrounded by boards resting against strong stakes firmly fixed in the clay. Then a *sheathing* is established, formed of a sill fixed upon the border of the planks that gives a contour to the *claires*, and surrounded with a network of galvanized iron wire running over its entire extent. This netting prevents crabs and other destroyers of the oyster from introducing themselves into the inclosures.

CONSTRUCTION OF THE INCLOSURES AND SLUICES.

CLEANING AND LIMING THE TILES.

The principal enemies of the oyster are certain dog fishes and skates (which crush the young shellfish between their jaws), the crabs, and a mollusk, which pierces the shell with its rugose skin. Certain ostrei-culturists replace the metallic net with fagots of heather, the use of which is much more economical. This heather is a strong and tall species which the proprietors of the parks cut and trim in the surrounding pine forests, where it grows in abundance. The fagots are fixed firmly in an upright position and very close to each other, in an open trench, at a distance of about 20 inches from the dikes. These two systems have the further advantage of keeping the young oysters within the inclosures, and of preventing them from being carried by the current into the adjoining parks.

Another system is employed for scaring away the numerous destroying fishes. It consists in surrounding the inclosures with young pines called *pignons.* These are very flexible, and about 10 feet in height, and are deprived of their branches except at their extremity, which terminates in a small green tuft. At high tide, these young pines perform the office of "scare fishes," so to speak.

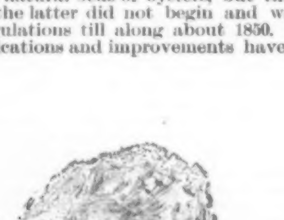
Further along proceeds the formation of the tile frames, which are of tarred wood and firmly fixed to the soil. These cages, which are about 6 feet in length, from 12 to 16 inches in width and 3 feet in height, contain eight or ten rows of tiles 12 inches in length, the convex side turned upward. The tiles, which are called "collectors," are first limed, that is to say, immersed in a bath of hydraulic lime mixed with a little fine sand, and are then dried for several days in the sun. It is to these tiles that the fry attach themselves in numbers varying from 2 to 300 per tile. The spawn is hatched within the oyster in spring. The interior of the oyster at this time contains a milky substance which causes it to be regarded as sick, and which lasts from May to September. To this is due the dictum that the oyster should be eaten only during the months containing in their spelling the letter "r." As the mother oyster is capable of producing about from 80,000 to 90,000 eggs a year, we have a mean of nearly three thousand million oysters, inclusive of the Portuguese in the proportion of 2 per cent., that the basin of Arcachon produces.

MANUFACTURE OF HEATHER FAGOTS.

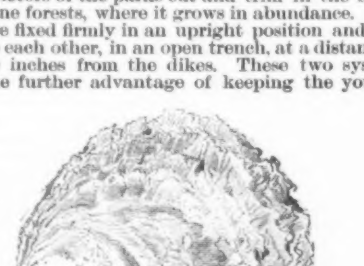
Toward the month of October the tiles are raised for the purpose of scraping them. This operation is easy but requires, nevertheless, to be performed with the greatest care, so as not to damage the young oysters. It must be finished before severe cold sets in. This work is generally done by young girls. It consists in placing the tile on a bench and detaching from it the 6 months to 1 year old mollusks, by means of a special knife, in such a way that a small fragment of lime (called *capsule*) shall remain adherent to the shellfish. Then the oysters are passed through two screens, the meshes of the first of which are three quarters of an inch in diameter and those of the second four tenths of an inch. Through the meshes of the first and second pass the very young fry; the others traverse the first screen and the large ones remain upon it. As soon as this operation is finished, the tiles are thoroughly cleaned and then limed again, later on, for the following year.

The oysters scraped from the tiles are afterward put into special boxes called "ambulances," invented some years ago by Mr. Michelet, an ostrei-culturist of Arcachon. These boxes, which are made of tarred wood, are about 6 feet in length by 3 in width. They are firmly fixed to the bottom of the park, are surrounded by strong stakes, and are divided into compartments and covered externally and internally with a tarred galvanized iron lattice permitting of the flow and circulation of water.

Here the oysters grow, and in a few months reach a size of from $2\frac{1}{2}$ to 3 inches. In addition to being covered by the tide, the oysters are moistened every day. They remain in the boxes three months, and



OYSTER SCRAPED FROM THE TILES AFTER 12 MONTHS.



OYSTER OF 30 MONTHS AFTER SOWING.

PUTTING THE PINE SAPLINGS IN PLACE.

then the sorting takes place. A portion of the oysters that are large enough are taken out in order to be planted in the inclosures, where they then become the object of the greatest care. Here they increase in size, fatten, and assume their flat form. When it is $1\frac{1}{2}$ inch in diameter, the oyster is edible, but it cannot be exported until it is 2 inches in diameter at a minimum.

There is nothing more interesting and picturesque than the collecting of the oysters. This takes place in the inclosures at low tide. It generally falls to the lot of the women, who wear an original and half masculine costume, with waist and cap of red cloth. Their legs are bare and they wear wide wooden shoes. The fisherwomen, standing in a single line like sharpshooters, begin the collecting at one of the extremities of the inclosure and stop all together to begin at another side. One hand is armed with a rake which scrapes the sand and exposes the oyster, which is picked up with the other hand and placed in a basket made of galvanized iron wire. The oysters are then placed on board of *pinasses* (boats with sails and special oars in the basin), and are afterward unloaded and sent to storehouses to be thence immediately exported either by steamboats or rail, or to be kept in reservoir pontoons called "backs." Here, sheltered from the inclemencies of the weather, they preserve their freshness and are always ready for consumption.

As far as possible, the reservoir pontoons are anchored very near the coast, either in front of the beach of Arcachon or upon the muddy shores in the vicinity of the numerous villages of fishermen that skirt the basin or are located on Bird Island, situated in the middle.

These villages offer a very strange aspect to the eye of the tourist. One might believe himself to have been suddenly transported to the middle of an encampment of Red Skins or of New Caledonians. Erected at random, in most cases without alignment, the dwellings are made of boards and roofed either with tiles or boards covered with tarred paper. Some are square, some are triangular, and some are conical or tent-shaped. The furniture in the interior is of a most rudimentary character, and, in most cases, of the fisherman's own manufacture. On the wall of the chimney we see the traditional huntsman's gun, the oyster parker being a great hunter, and game being very abundant on the basin. At the side of his house there is a hut for storing his tools and apparatus.

All around these huts lie, in inextricable confusion, instruments and objects of all sorts in a state bordering more or less on old age: scraping tables, wheelbarrows with wide wheels for facilitating their movement over the sand, nets, ambulance cages, scraped tiles, etc., etc. Amid all this, the fisherwomen in red breeches, and the fishermen with big boots, their arms loaded down with their various apparatus, come and go, and embark and disembark. It is a most animated spectacle, and one in which the picturesque abounds.

In the center of the basin there are a large number of pontoons for the use of the guardians of the parks—a wise provision these, for numerous are the malefactors that after nightfall slip noiselessly through the canals in order to steal the products of some unfortunate park owner. There is no challenge given here.

CONSTRUCTION OF THE TILE FRAMES.

SCRAPING THE TILES.

SOWING IN OYSTERS IN THE PARKS.

PLACING THE YOUNG OYSTERS IN THE AMBULANCES, AND WASHING OF THE LATTER.

GATHERING THE EDIBLE OYSTERS IN THE PARKS.

but the sharp crack of a rifle, fired opportunely, arrests the ardor of the brazen-faced thief.

The park owners thus do their own police duty.

There is, indeed, a government gunboat, resembling a washerman's boat, incapable of going to sea, and carrying a military crew whose place would be more useful in a port of war; but this guard boat guards nothing, does no serious police duty, and serves only as an agreeable sinecure for a few good fellows—true descendants of the carabineers of Offenbach—who might be exercised in a much more intelligent manner in their calling of sailors.—*L'Illustration.*

ARTIFICIAL OYSTER CULTURE IN FRANCE.*

IN 1872 the increased price of oysters in France attracted public attention. Those who were commissioned to investigate the cause found that it was due, in the first place, to the diminished supply; second, to the increased demand for the mollusk in Russia, Germany, and other countries; and, third, to the establishment of a monopoly by the great dredging companies. The *Economiste Francais* drew a comparison in the relative price of oysters per hundred, covering a period of some 20 years or more. For example, in 1840 oysters were to be had for 23 cents a hundred; in 1856 the same quantity commanded 55 cents; in 1860 they were quoted at 90 cents; in 1868, at $1.45, and in 1872, at $2.60.

The increased demand was natural. The dredging monopoly could not well be attacked, but the French government immediately set about increasing the general supply by having investigations made by experts and by offering certain encouragements to the owners of beds. Artificial cultivation was the method suggested, and that the results have been profitable there can be no doubt.

The oyster is one of the most prolific breeders known to natural history. Leeuwenhoek calculated that from 3,000 to 4,000 spawn exist in the ordinary sized bivalve at breeding time. Poli declares that a single oyster is capable of producing 1,200,000 eggs. Other scientists have placed the number as high as 2,000,000; but, admitting Poli's estimate to be the correct one, it would seem that the supply of these favored dainties would at least approximately meet the demand. Yet such is not the case; for, when the parent expels its young, which have been previously hatched within the shell, many are carried away by the current to unsuitable situations, where they either die or are devoured by fish. Those immediately finding an object to which they can attach themselves thrive.

Oysters thrive equally well in situations where they are constantly under water and in those which are left dry at low tide. The methods of providing artificial beds are varied in accordance with the nature of the bottom and the probable violence of wind and wave. Experience in France has proved that tiles covered with cement and immersed along the beach afford the most advantageous means of catching these shellfish. These objects present a surface to which the mollusk can best attach itself and from which it can afterward be readily detached by the fisherman. Then, again, these portable bits of brick and mortar can easily be moved from place to place. This is a matter not to be ignored, for it is often found by the cultivator that, after having caught the oyster or after having found a successful breeding place for the same, the process of fattening requires the temperature of an entirely different shoal.

One of the most important spots in France where attention is given to the culture of the oyster is Arcachon, a little fishing village and summer resort situated on one of the great basins or inlets of the Bay of Biscay and not a great distance from the city of Bordeaux. The Bay of Arcachon was at one period crowded with natural oyster beds: but, in course of time and owing to excessive dredging, they became almost completely exhausted. To-day the industry has again assumed its pristine proportions, for the bivalves are cultivated artificially and nurtured with the greatest attention and care. The entire sea bottom, or that portion of the bay that can with facility be dredged, is divided into inclosures by the driving in of stakes. In the inlet of Arcachon over 12,600 acres are given to these inclosures. In some instances nets are attached to the marine fences for the purpose of excluding fish or lobsters, which are great lovers of the luscious oyster when in the state of early development. It is within these beds—or "parks," as they are called—that the tiles before mentioned are immersed. These mortar-covered fire bricks usually have a surface of about two square feet and offer a resting place for five or six hundred mollusks. Upon this object the oyster grows famously; so rapid is its progress, in fact, that it is often found necessary for the proprietor of the "park" to raise the numerous tiles to the surface in order to scrape off the bivalves, while he sinks an additional hundred or so of these objects, that there may be afforded a new and more commodious home for those which have been detached from their first resting place.

The dredging, of course, takes place during the season, which in Europe, as in America, extends over all the months of the year containing in their spelling the letter "r." The French oysters are distinctly different in their appearance and taste from their transatlantic brethren. The shells are not so deep as those of Blue Point, Chesapeake, Shrewsbury, or Rockaway. The oyster itself is of a greenish tinge, and their flavor is excellent. They are eaten always raw and served on the half shell. The French never cook the oyster, nor can they understand how it is possible to eat them in that state. This seems more than odd in a country which has such a wide reputation for the variety of its dishes and the excellence of its cuisine.

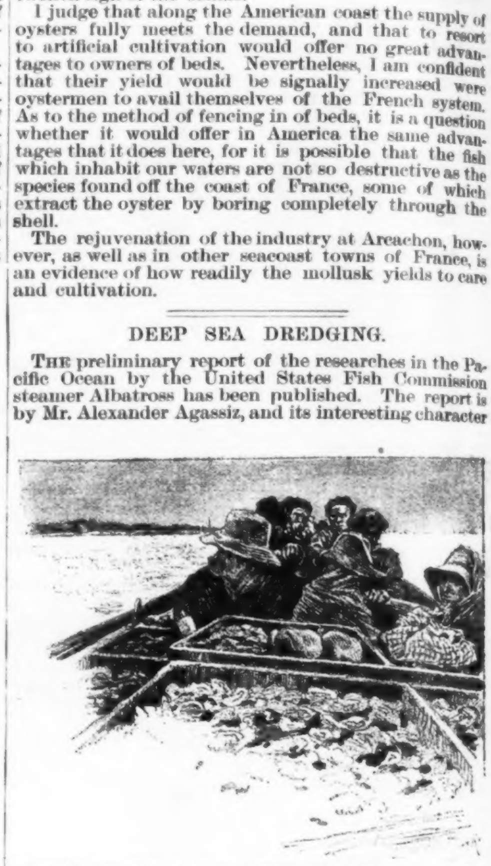
The history of the oyster has been too often told to suffer repetition here. Certain it is that the favored dainty was highly popular with the ancients, for Pliny, to whom one may always go for information, states that their cultivation was practiced extensively along the Tyrrhenian coast, and that one Sergius Orata, who had an oyster bed at Baiæ, "not for gluttony, but for the sake of gain," derived a large income from the same. Alexander, in his conquest of India (B. C. 324), declares that he found oysters a foot long. Modern fishermen may accept or distrust this assertion, as they like; for, whereas the illustrious Grecian general was noted for his integrity, there is no subject which favors in so pronounced a degree the fanciful flights of the imagination as that which is represented by the twelfth sign of the zodiac.

I judge that along the American coast the supply of oysters fully meets the demand, and that to resort to artificial cultivation would offer no great advantages to owners of beds. Nevertheless, I am confident that their yield would be signally increased were oystermen to avail themselves of the French system. As to the method of fencing in of beds, it is a question whether it would offer in America the same advantages that it does here, for it is possible that the fish which inhabit our waters are not so destructive as the species found off the coast of France, some of which extract the oyster by boring completely through the shell.

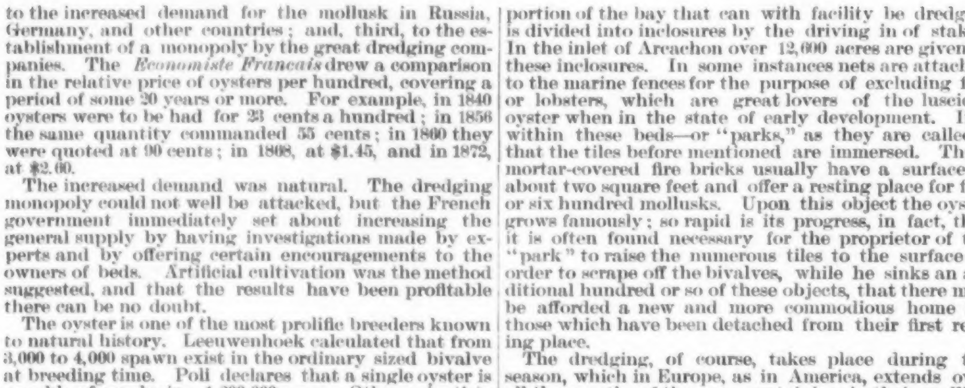
The rejuvenation of the industry at Arcachon, however, as well as in other seacoast towns of France, is an evidence of how readily the mollusk yields to care and cultivation.

* Report by U. S. Consul H. G. Knowles, of Bordeaux.

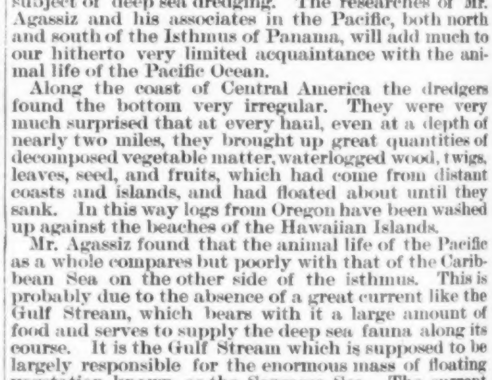
CARRYING BOXED OYSTERS TO THE STOREHOUSES.



INTERIOR OF A PINASSE, WITH ITS LOAD.



A VILLAGE OF PARK OWNERS ON THE BASIN OF ARCACHON.



A GUARD BOAT.

DEEP SEA DREDGING.

THE preliminary report of the researches in the Pacific Ocean by the United States Fish Commission steamer Albatross has been published. The report is by Mr. Alexander Agassiz, and its interesting character is certain to arouse fresh attention to the important subject of deep sea dredging. The researches of Mr. Agassiz and his associates in the Pacific, both north and south of the Isthmus of Panama, will add much to our hitherto very limited acquaintance with the animal life of the Pacific Ocean.

Along the coast of Central America the dredgers found the bottom very irregular. They were very much surprised that at every haul, even at a depth of nearly two miles, they brought up great quantities of decomposed vegetable matter, waterlogged wood, twigs, leaves, seed, and fruits, which had come from distant coasts and islands, and had floated about until they sank. In this way logs from Oregon have been washed up against the beaches of the Hawaiian Islands.

Mr. Agassiz found that the animal life of the Pacific as a whole compares but poorly with that of the Caribbean Sea on the other side of the isthmus. This is probably due to the absence of a great current like the Gulf Stream, which bears with it a large amount of food and serves to supply the deep sea fauna along its course. It is the Gulf Stream which is supposed to be largely responsible for the enormous mass of floating vegetation known as the Sargasso Sea. The current tears the seaweed from its place of origin along the coasts, and it is borne northward and then southwestward by the Azores branch of the Gulf Stream until it is massed in the Sargasso Sea, where it gradually becomes heavier until it sinks into the depths and is replaced by fresh supplies.

In the Pacific area explored by the Albatross there are currents enough, but the amount of food they bring is very small compared with that which drifts along the great ocean rivers of the Atlantic. There is, therefore, remarkable poverty of the surface life in comparison with the myriads of animals, embracing hundreds of species and scores of families, which in some of the warm seas have filled the towing nets of the deep sea investigators.

Mr. Agassiz found that many of the species of animals on both sides of the isthmus are identical. Yet most of his finds, though often of the same type, were specifically different, and many of the species were so utterly unlike the species found in the neighboring Caribbean Sea that a barrier as wide as a continent might well have been thought to separate the two faunas instead of the little thirty miles trip of the Isthmus of Panama. In the Caribbean Sea, where Agassiz and

his associates on the Albatross had previously pursued exhaustive investigations, sea urchins and their allies of endless strange forms were very abundant, but in the neighboring Pacific Ocean they were found to be very scanty. The absence of deep sea corals, which play so important a part in the greatest deeps of the West Indian waters, is also strikingly marked. The familiar types living among the "Globigerina ooze" on the sea bottom among the deposits of microscopic shells which have piled up the vast deposits of chalk characteristic of the cretaceous period, were found. As a rule, the deep sea fishes and other animals found were without eyes, showing that they had no need of them. Some, however, had very bright colors, which would seem to indicate that light penetrates to prodigious depths. Many of these animals burst open when brought to the surface, which shows the enormous pressure to which they are subjected.

Mr. Agassiz has probably cleared up to the satisfaction of oceanographers one long-disputed question relating to the distribution of the zones of animal life. It has long been known that a group of animals was characteristic of the surface while another was equally peculiar to the bottom of the ocean. These facts were ascertained very early in the investigation of marine geography. The naturalists of the Challenger expedition thought they had facts to sustain the theory that there is an additional and intermediate fauna with characteristic species found only in the intermediate ocean depths and having nothing in common with the other two. Dr. Chun denied this on the basis of his observations in the Mediterranean. He affirmed that the pelagic or surface life extended all the way to the bottom. Mr. Agassiz has always held as the result of his deep sea researches that the theory of Dr. Chun was not proved, while he has at the same time contended that there was no such intermediate fauna as the Challenger investigators described, though it was possible that during the day time the denizens of the surface might descend to a considerable depth in order to escape the light and heat, and the disturbing influence of surface winds. He seems to have entirely confirmed this view by his repeated observations in the Pacific. He found that the pelagic forms descend at times to as much as 200 fathoms from the surface, but after this there is a barren region until at some sixty or seventy fathoms from the bottom the deep sea rovers begin to appear.

The investigators of the Albatross made a number of other very interesting discoveries. It will not be, however, until the immense collections of animals and sea plants are properly studied and described that the full value of these researches will be known. As yet the science of oceanography is in its infancy. The half dozen deep sea dredging vessels have left vast untouched spaces between their tracks across the ocean. We are, however, in a position to come to some general conclusions with regard to the geography of the sea.

It was held a few years ago that the bottom of the sea was practically a counterpart of the land, with its hills and valleys, mountain peaks and deep glens. Recent expeditions have greatly modified this idea. Here and there, to be sure, peaks shoot up from the abyss, forming an island, or approach the surface of the ocean within a few hundred fathoms; and there are ocean glens into which the sounding line sinks until it seems as though it would never reach the bottom. But researches have progressed so far as to prove that the ocean beds as a rule undulate very gently, so that if an observer could stand among them it would be found that their contour appeared like that of a rolling plain.

Years ago the celebrated Maury was the great authority upon oceanography. It was his opinion that eight or nine miles was no extravagant depth for mid-ocean. The recent investigators, however, have been unable to find a greater depth than two or three miles north of the sixtieth parallel of latitude or south of the same distance from the Antarctic Pole. A depth of five or six miles is quite exceptional, and an average of 2,500 fathoms is not more than the mean of the entire waters of the globe. The deepest soundings yet taken are 4,655 fathoms, off the northeast coast of Japan, one of 4,575 fathoms south of the Ladrones, and a third of 4,561 fathoms north of Porto Rico, not far from St. Thomas. The greatest depth found in the North Atlantic is 4,561 fathoms, and in the South Atlantic bottom has always been found at a lesser distance. No part of the Mediterranean is known to be more than 2,150 fathoms deep, and the maximum depth of the Indian Ocean, as far as ascertained, is 3,199 fathoms. The polar basin seems to grow shallower the nearer the North Pole is approached, until at latitude 62° 30′ 26″, within four miles of the most northern point ever reached, Capt. Markham found bottom at seventy-two fathoms.

A great deal of land exploration is conducted by private enterprise, but it is impossible for private individuals to carry on extensive researches in the sea depths. The cost of the apparatus and the maintenance of the vessels is great, and it is not likely that these inquiries will ever be carried on except as government enterprises. One branch of oceanography has, however, been investigated to some extent by the aid of private resources, as, for instance, ocean currents, and the Prince of Monaco and some others depending upon their own means have achieved some results.

WHAT IS AN ANT?

By E. A. BUTLER.

OF late years the ant, as every one knows, has become the pet of the scientific world, and, to some extent, of the unscientific also. The fierce light of publicity has been brought to bear upon these little creatures, and upon their secret and subterranean doings. The laws which govern their communities, their common labors, their wars and foraging expeditions, their individual intelligence as manifested in their power of distinguishing their friends and detecting aliens, their vision and perception of color, their senses of smell and hearing, their devotion to their young, their development and the duration of their life—these, and other such items, have been made the subject of observation and experiment, and the results have been eagerly read and discussed even in the daily press.

But notwithstanding that ants have become so famous, and their doings have been so minutely chronicled, there does not seem to be in the minds of the public generally a very distinct idea as to the identity of the creatures themselves, or, in other words, as to what insects are ants and what are not. When an entomologist shows his collections to non-entomological friends, if he happen to have among his specimens any little dark-colored, long-legged, wingless creatures, he is pretty sure to hear the suggestion hazarded in an inquiring tone that these must be ants. Such a supposition will, it is likely, be quite as often wrong as right. The popular conception of an ant is no doubt derived from the little black or dark brown wingless individuals which one meets with everywhere, in our gardens and around our houses, quite as much as in the fields, lanes, or woods. But a conception which is formed merely by a random glance at such minute objects in rapid motion, and seen without the help of a magnifying glass, cannot but be vague in the extreme, and it is not surprising, therefore, that mistakes should frequently be made. The scientific idea of an ant must be a good deal broader as well as a good deal more definite than this popular conception, and it is our purpose in this paper to show what are the distinctive characteristics of ants, and how they can be distinguished from the numerous other insects to which they bear a superficial resemblance.

One cannot pronounce offhand of any little dark-colored, wingless, running insect, that it is an ant, and on the other hand, many true ants would be neither dark colored nor wingless. Certain definite structural characteristics which are accompanied with certain well-marked peculiarities of economy and habits serve to distinguish ants from other insects. Though what we have to say in this paper is intended only to apply to British ants, it will be as well at the outset to correct a possible misapprehension, and to observe that there is a well-known tribe of insects which inhabit tropical regions, and no members of which are natives of Britain at all, that have unfortunately been called ants, though they are of an entirely different nature, whereby has resulted great confusion of popular zoological ideas. The insects in question are the so-called "white ants," better named termites, whose ravages are one of the greatest trials and annoyances of tropical countries. These destructive insects we have, quite apart from geographical limitations, nothing to do with here; zoologically they are not ants at all: their structure is very different from that of the true ants, and in many important respects their economy and habits are also strikingly dissimilar. The reader will therefore be good enough to exclude these creatures from his thoughts, and bear in mind that nothing that is said has any reference to them. The insects whose characteristics we have to consider are those which in this country are known as ants or emmets. We have between twenty and thirty kinds of them in this country, and these differ greatly in color, ranging from the palest yellow, through various shades of red and brown, to deep jet black. Nevertheless there is a family likeness about them that renders them easily recognizable when once the distinctive points are known.

The first of these is to be found in the form of the insect. There is a large head (see Fig. 1), which is more

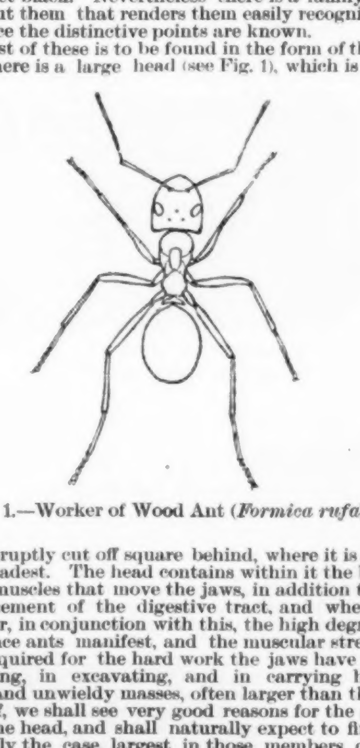


FIG. 1.—Worker of Wood Ant (*Formica rufa*).

or less abruptly cut off square behind, where it is often at its broadest. The head contains within it the brain and the muscles that move the jaws, in addition to the commencement of the digestive tract, and when we remember, in conjunction with this, the high degree of intelligence ants manifest, and the muscular strength that is required for the hard work the jaws have to do in fighting, in excavating, and in carrying heavy weights and unwieldy masses, often larger than the insect itself, we shall see very good reasons for the great size of the head, and shall naturally expect to find it, as is really the case, largest in those members of the community which have to do most of the work, whether mental or physical, viz., in the workers. The head is succeeded by a hump-backed thorax, often the narrowest part of the body, and showing very distinctly its composition out of three distinct segments. Then follows the abdomen, which is often extremely small in proportion to the other parts. Now it is in the construction of this part of the body that one of the most characteristic ant features is to be found. The front part of the abdomen is drawn out into a kind of thin stalk, which forms the connecting link between it and the thorax. But as this is the case with the majority of the Hymenoptera, to which order the ant belongs, and gives them the narrow-waisted appearance which is familiar in wasps and ichneumon flies, it is not in the mere presence of this petiole, as it is called, that we find the distinguishing feature, but rather in its peculiar form. The petiole is raised on its upper surface into one or two prominences, which have been called "nodes" or "knots." The form of these, and the remarkable outline they give to this part of the insect, can best be seen by a side view (Fig. 2). The presence of these "knots" is one of the features by which an ant may be recognized at once, and more than that, their number will determine to which of our two chief families any given specimen belongs. Omitting two rare insects which represent the family *Poneridæ*, but which are not likely to come in the way of the ordinary observer, and which, for practical purposes, may therefore be disregarded here, our British ants are arranged in two families, the *Formicidæ* and the *Myrmicidæ*, the former, which contains the black and brown species we find in our gardens and streets, having only one "knot," and the latter, which contains the red ones, having two. The petiole is movably jointed to the hinder part of the thorax, and hence the abdomen as a whole can be bent about this joint as upon a hinge.

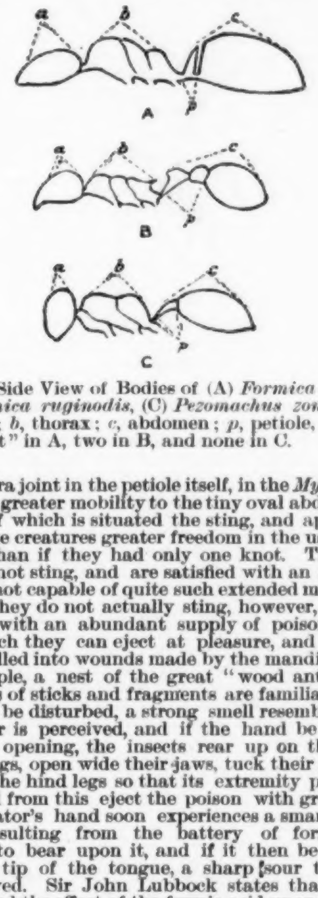


FIG. 2.—Side View of Bodies of (A) *Formica rufa*, (B) *Myrmica ruginodis*, (C) *Pezomachus zonatus*. *a*, head; *b*, thorax; *c*, abdomen; *p*, petiole, with one "knot" in A, two in B, and none in C.

The extra joint in the petiole itself, in the *Myrmicidæ*, gives still greater mobility to the tiny oval abdomen, at the end of which is situated the sting, and apparently gives these creatures greater freedom in the use of that weapon than if they had only one knot. The *Formicidæ* do not sting, and are satisfied with an abdomen which is not capable of quite such extended movement. Though they do not actually sting, however, they are provided with an abundant supply of poison (formic acid), which they can eject at pleasure, and which is thus instilled into wounds made by the mandibles. If, for example, a nest of the great "wood ant," whose huge piles of sticks and fragments are familiar objects in woods, be disturbed, a strong smell resembling that of vinegar is perceived, and if the hand be brought near the opening, the insects rear up on their hind pairs of legs, open wide their jaws, tuck their abdomen between the hind legs so that its extremity points forward, and from this eject the poison with great force. The operator's hand soon experiences a smarting sensation resulting from the battery of formic acid brought to bear upon it, and if it then be touched with the tip of the tongue, a sharp sour taste will be observed. Sir John Lubbock states that he has experienced the effect of the formic acid upon the hand when held at a distance of as much as eighteen inches. If the head be held over a disturbed nest, a little distance above it, the atmosphere is found to be so impregnated with the fumes of the acid as to be almost overpowering.

Among the ichneumon flies and allied insects, there are to be found many species which are wingless, and which, as they run about on the ground, among dead leaves or other rubbish, or over the foliage of living plants, look a good deal like ants. They may, however, be distinguished by an appeal to the knotted petiole test. The petiole is indeed to be found in such insects, as their narrow waist at once testifies, but it has not the characteristic knots, as a glance at the accompanying figure (Fig. 2) will show. The insect whose body is represented in profile, and a portrait of which is given in Fig. 3, is a parasite on spiders, and has no connection with ants, leading as different a life as could possibly be imagined.

The second feature of importance in distinguishing ants from other insects is to be found in the antennæ. These are always of the same type. There is a little roundish joint by which they are attached to the head in front of the face (Fig 1). This is succeeded by a long slightly curved shaft, occupying about a third of the length of the whole antenna; this is called the "scape." This, again, is succeeded by a string of small joints, the number of which depends upon the species and the sex; sometimes these increase in width a little before the tip, and so give a club-shaped appearance to this flexible part, which, from its flexibility as contrasted with the stiffness and rigidity of the scape, has been called the "flagellum" (*Latin*, whip), the lash, of which the scape is the handle. Now, bees and wasps also have antennæ constructed like this, but as they are never wingless, they are not likely to be mistaken for ants, notwithstanding their "elbowed" antennæ.

A greater difficulty will be felt in distinguishing winged ants from wild bees, but here the scale or knot on the petiole will come to the student's assistance and settle the matter. If we look now at those other wingless Hymenoptera which are not ants, we see that this antennal feature may again be used as a means of discrimination. It is true that in such insects the second joint of the antennæ is a good deal longer than any of the rest, and sometimes (especially in the very small species) even as long as in the ants. In such cases the knotted petiole test must be applied. But in many instances the second joint is not nearly so long as in the ants, and then the many-jointed terminal part is not placed at an angle to the rest, so that the antennæ do not become "elbowed" (Fig. 3). This is more evident in the living insect than in the dead one. The ant's antennæ are carried pointing forward, but with the flagellum set at an angle to the scape, like a human arm bent at the elbow, and then the whole organ and its two chief parts can be placed in the same variety of positions as the arm which it imitates; the antennæ of the *Pezomachus* above mentioned and other parasites are not carried bent in this way, but straight forward, and their tips are maintained in an incessantly quivering or vibrating condition, as the insect goes on its way.

It is astonishing what differences of expression can be imparted to the head by the varying positions of the antennæ. The importance of this is seen when we

bear in mind that an ant's head, like that of any other insect, is covered with a hard, unyielding skin, any movement in which is absolutely impossible; all expression of the emotions, therefore, must be restricted to the movement of external parts, like the jaws and antennæ, and to the varying positions of the head itself; in fact, nothing more devoid of expression can be imagined than an ant's head, apart from the jaws and antennæ; the fixity of the eyes and the

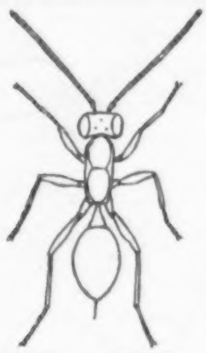


FIG. 3.—*Pezomachus zonatus*, a parasite on spiders; not an ant.

bloated appearance of the head itself make it look as unintellectual as the helmet of a diver. And yet this expressionless object can have a strong semblance of an air of warlike courage and bold defiance, of intelligent appreciation and affectionate sympathy, of industrious effort and fussy energy, imparted to it, simply by varying its position and by altering the attitude and motion of the jaws and antennæ.

Hitherto, we have been speaking only of the wingless forms of ants, but these, though by far the most numerous, by no means constitute the whole of any given species. Every ant exists in three forms, the male, the female and the worker. Both the male and the female always have wings when first they assume the perfect form; the latter sex, however, retain them only till the marriage flight is over: they then voluntarily tear them off, so that in this sex the wings are only temporary appendages. These winged forms are seen for so short a time during any single season that many people no doubt have never noticed them at all, and find it difficult to believe that such things exist. But even when one does see them, which will probably take place some fine day in August or September, it is often difficult to recognize them as having any connection with the wingless workers with which one is so familiar. It is clear that if two pairs of membranous wings, one large, the other small, be supposed to be added to a worker ant, such an addition would of itself greatly alter the appearance of the insect. But this is by no means the only difference; there is also often a striking dissimilarity both with regard to size and color, and the males, which are the smaller of the two, are frequently also much unlike their partners in color and shape. For example, the little yellow ant (*Lasius flavus*), which is abundant in many meadows and on heaths, making little hillocks, or taking advantage of the protection of a large stone or loose piece of rock, is yellow only in the worker; the male and female are both brownish black; or again, the little thin red ant (*Myrmica rubra*), which is common everywhere, has a dark blackish brown male, which, in consequence of its wings and its deep color, would be supposed to be a totally different insect from the worker or the female. It is, then, only the workers that have no wings, or the females after they have mated, but then in this latter case the stumps of the wings may still be seen, whereas in the workers two little rounded points alone represent that portion of the larval structure which in the males and females develops into wings.

The development of wings in the male and female ants has an important influence on the shape of the thorax, which adds another means of distinguishing the latter from workers when they have lost their wings. In the workers, the three segments of the thorax are not very unequal in size (Fig. 2), as each contains similar sets of muscles, viz., those for one pair of legs only; but when the wings are developed additional muscles are needed for these, and must be accommodated in the two hinder segments; hence the prothorax (first segment) becomes overlapped by the greatly enlarged mesothorax (second segment), which gives a still more humpbacked form to the insect, and the metathorax also (third segment) becomes enlarged. The enlargement is greatest in the mesothorax, as that segment has to carry the first pair of wings, which is by far the larger of the two, and is the chief instrument of flight. The wings are composed of transparent membrane, more or less clouded with a smoky tint, and strengthened by a few nervures, which inclose only a small number of cells.

Now the other wingless Hymenoptera with which ants are often confounded do not exist in these three forms; all examples met with will be either males or females, no such things as workers being known, for a very good reason, viz., that there is no work for them to do. The insects do not form communities, but are, as already mentioned, piratical in habits, each managing its own affairs, which, in the case of the female, consist of little more than finding a suitable host in whose body she may deposit her eggs. These insects do not, as the ants, couple in the air, and therefore never have any wings at all. It will be impossible, then, ever to find such insects in communities, or winged, in both of which respects they are to be distinguished from ants. It should be observed, however, that some species, of which the females are always wingless, have winged males.

We are now in a position to answer our query "What is an ant?" We have seen that ants are Hymenopterous insects, which live in communities comprising three types of individuals, males, females, and workers; that the two former ones are winged and are to be met with only at a certain season in the year, but that the latter are never winged; that the antennæ are elbowed, and that the abdomen is attached to the thorax by a knotted petiole. And as they possess a poison gland and either a rudimentary or fully developed sting, they are referred to that section of the order called the "Aculeate" (sting-bearing) Hymenoptera, which also contains bees, wasps, and some other insects. Lastly they constitute a compact group of this section, to which the name Heterogyna has been given, in consequence of the great size and very different appearance of the females (*Greek:* dissimilar females).—*Knowledge.*

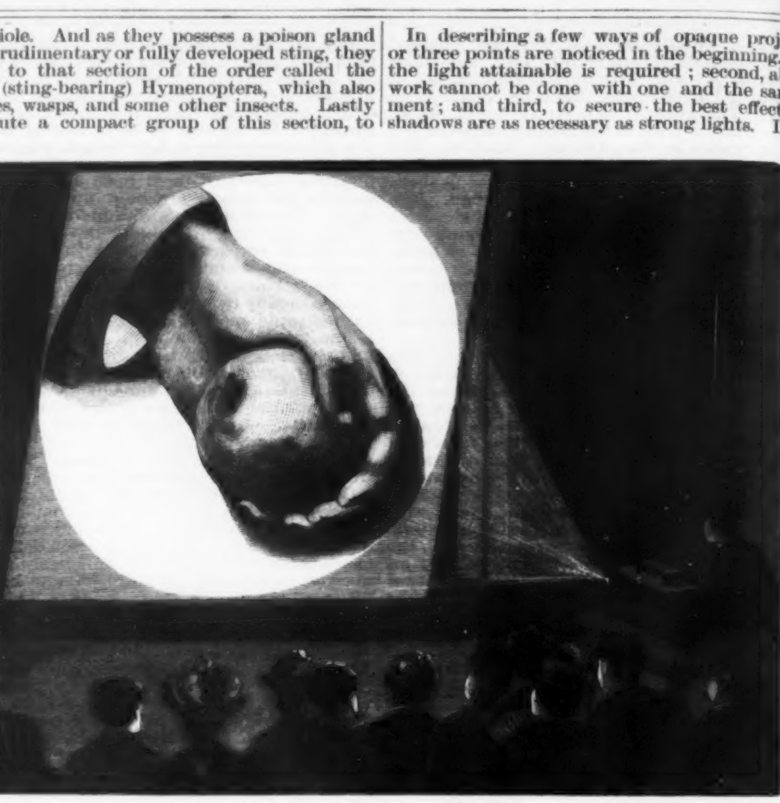


FIG. 1.—THE MEGASCOPE.

OPTICAL PROJECTION OF OPAQUE OBJECTS.

By GEO. M. HOPKINS.

THE projection of opaque or solid objects by means of the optical lantern affords a way of showing upon the screen a large variety of objects in their natural colors, and greatly magnified. The form of lantern

FIG. 2.—MEGASCOPE BOX, SHOWING POSITION OF BURNERS.

best adapted to this purpose is the simplest imaginable.

The works on optical projection briefly describe different forms of apparatus for this purpose. Prof. A. E. Dolbear in his book describes a megascope, consisting of a plain box, with a large lens in front and an oxyhydrogen light within. Mr. Lewis Wright, in his new work on "Optical Projection," shows two or three forms of megascope; but notwithstanding all this, the idea is current that opaque projection is difficult, and several persons known to the writer are so thoroughly convinced of the magnitude of the undertaking that they do not make the attempt to project in this way.

In describing a few ways of opaque projection two or three points are noticed in the beginning. First all the light attainable is required; second, all kinds of work cannot be done with one and the same instrument; and third, to secure the best effects, suitable shadows are as necessary as strong lights. It is useless to attempt projection on a large scale with a source of illumination inferior to the calcium light. For large objects and a large screen, two large burners are essential, and the use of three insures a much better effect.

The length of the box inclosing the object and the burners is determined by the focal length of the object glass. In the instrument illustrated, the lens has a focal length of 24 in. The box is made 4 in. longer,

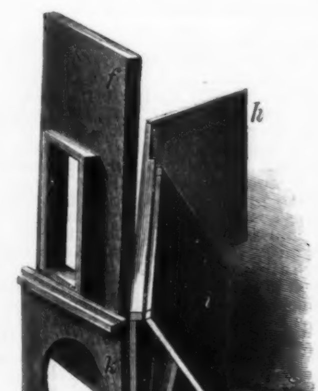


FIG. 3.—FOLDING BOX PARTLY CLOSED.

i. e., 28 in., to allow of moving the object, for the purpose of focusing the image on the screen.

When two oxyhydrogen burners are used, they are arranged at one side of the megascope box, at slightly different elevations, and a short distance apart, to se-

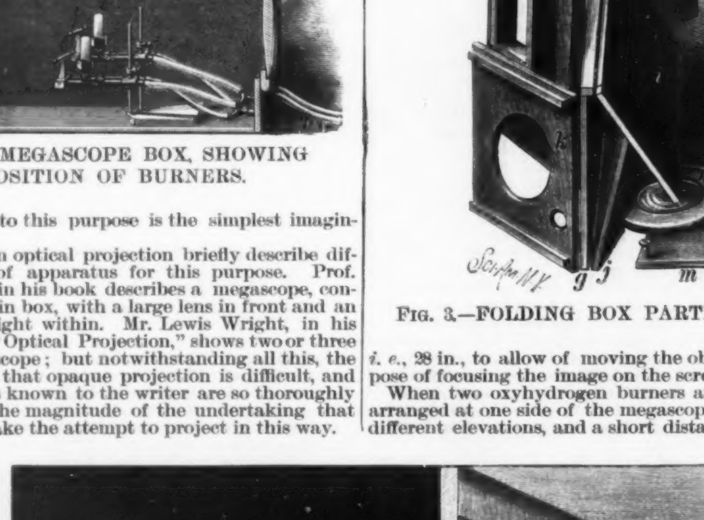


FIG. 4.—MEGASCOPE WITHOUT BOX.

cure soft shadows. When three burners are used, the third is placed at the opposite side of the box. It increases the volume of light and modifies the shadows. If the apertures of the burners are the same, they may all be supplied with gas from a single pair of cylinders, by using branch pipes. The burners should be pushed as near the object as possible, without bringing them into the field of the objective.

In the present case the objective consists of a 6 in. double convex lens, but a 7 or 8 in. would be better. The lens is mounted in a soft wood ring, and suspended over a circular aperture in the front of the box. Opticians, are preferable, on account of being about the right focus. They are not expensive and can be obtained of a diameter of six or seven inches. Two or three calcium lights are used. The objects may be held in front of a white or tinted background, or the background may be omitted. It is absolutely necessary that no stray light should escape into the room in which the image is thrown. Of course an opaque white screen may be used in this arrangement if desirable.

For the projection of fine objects, such as gems and their settings, a watch movement, or a fine piece of machinery or apparatus, the arrangement shown in Fig. 5 is effective. A plan view of the apparatus is here shown. The objective of the lantern is removed and supported at an angle with the optical axis as indicated. The lime is pushed forward so as to cause the divergent cone of light to cover the object, d, as shown. The light reflected from the object, d, passes through the objective to the screen.

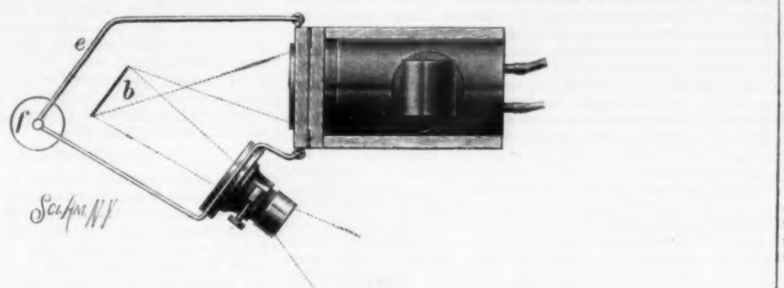


FIG. 5.—MEGASCOPE ATTACHMENT TO LANTERN.

For the sake of convenience, the box is made to fold, so as to occupy a space of 18 by 28 in. by 3 in. thick, when not in use. Fig. 3 shows the construction clearly. The top, f, is like an ordinary box cover, with the exception of the central draught hole surrounded by a collar.

To the bottom, g, are hinged the end, h, sides, i j, and the front, k. The cap, m, is supported over the opening in the center of the cover, f, by the wood screws inserted in the corners. The lens, n, is arranged to hang over the large opening in the end piece, k. In this end piece there is a smaller opening for the insertion of the gas tubes. The side piece, i, is discontinued near back end of the box, to provide an opening for the insertion and removal of objects. This opening is covered with a black curtain, which falls over the arm and prevents the escape of light. Upon the inner surface of the back end of the box is secured a piece of white cardboard for a background.

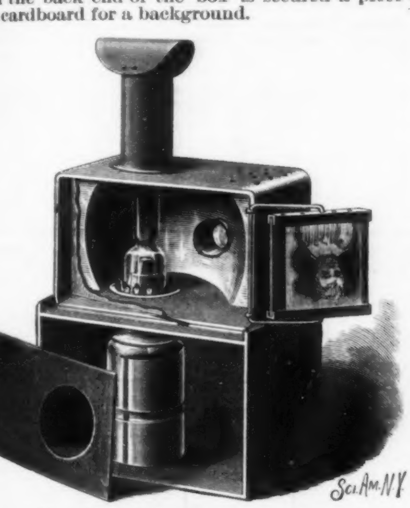


FIG. 6.—WONDER CAMERA.

The sectional view, Fig. 2, best shows the internal arrangement.

The object must be inserted in position and moved forward or backward until it is focused. If difficulty is experienced in holding the objects properly for exhibition, they may be placed on a movable support.

Fruit of all kinds projects well, either whole or divided. A bunch of California grapes forms a fine object. A bouquet of flowers is beautiful. Shells, especially polished ones, are very pleasing objects. Peacock and other feathers show well. Pottery and bronzes, plaster casts, toys of various kinds, particularly of the Japanese variety, carvings, embroidery, paintings, engravings, photos, the pages of a book, are all of interest. Whole machines of a suitable size, and parts of machinery, or apparatus of almost any kind may be shown to advantage in this way.

Another way of accomplishing the same result with-

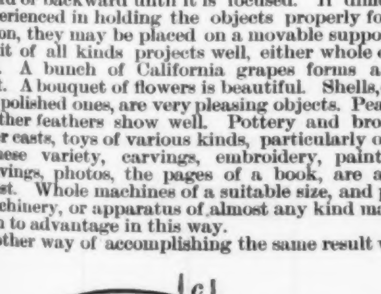


FIG. 7.—PLAN OF WONDER CAMERA.

out the use of a box is illustrated in Fig. 4. In this case one room serves as a megascope box and another as the room in which to place the screen. The same general arrangement as that already described is observed. In this case the lens is secured over the space between two sliding doors, and all escape of light is prevented, excepting, of course, that which passes through the lens. The screen is made of translucent tracing paper. The lens may be such as is used for the examination of paintings or photographs, but the kind known as cosmorama lenses, sold by the principal op-

The wire frame, e, secured to the front of the lantern and held by the standard, f, is designed to support a thick black cloth for shutting in all light excepting that passing through the objective. Appratus similar to this in principle is sold by some of the dealers in lanterns.

The wonder camera shown in Fig. 6 is an instrument having a marvelous amount of power considering the source of light, which is simply a single Argand kerosene burner. This toy is furnished by Ives, Blakeslee & Williams Company, of this city.

The lamp flame is in one focus of the ellipsoidal reflector, and the picture or object to be shown is placed at the other focus, on the swinging adjustable holder. Opposite the holder in a perforation in the reflector is placed the objective by which the image is projected on a screen three or four feet distant. The small plan view shows the shape of the mirror and the course of the light. The linings of the box around the lamp and focus of the reflector are removed in the picture to show the interior. These linings are made of asbestos, to withstand the heat. This instrument will project coins, shells, flowers, pictures, etc., very satisfactorily.

THE SANITARY INSTITUTIONS OF PARIS.*

Ambulance Stations.—The sanitary institutions of Paris that we have already described are completed by two ambulance stations situated on De Stael and Chaligny Streets. These stations are designed to permit of the transfer of patients from their dwellings to the hospitals, especially in case of contagious diseases. The prefecture of police had already organized and still possesses ambulances which are somewhat inconvenient for this same service, and, as well known, a private association also provides ambulances for the same purpose. The establishments to which we call attention, like the night refuges and the disinfecting stations, are under the control of the municipal affairs at the prefecture of the Seine. They present guarantees and advantages incomparably superior to those of the services that we have just recalled.

* Continued from Supplement No. 845, p. 13510.

The De Stael Street station is designed solely for this service, while the Chaligny Street one comprises also a disinfecting station. Both include a separate building for the office, a house for the superintendent of the station and quarters for the nurses, as well as wagon houses and stables, with quarters for the serving men, so arranged that the disinfection of the ambulances can be effected in a yard and a special house. The ambulances make their exit from one door and re-enter through another.

The ambulances of these establishments are designed for the carriage of the sick to the hospital, to their residence, or to any other place previously designated. Some, to the number of five in each station, are used for cases of contagious diseases, such as diphtheria, measles, scarlatina, smallpox or typhoid fever. Another is utilized for patients attacked with a non-contagious disease. The vehicles have four wheels provided with rubber tires, and are drawn by one horse (Fig. 1). The corners are rounded in the interior and the sheet iron sides are painted and varnished. They contain a flexible metallic seat for the nurse and a litter for the patient. A rubber tube permits of communicating with the driver. They include no drawers for the carriage of the clothing and bedding of the patient, this service being incumbent upon the disinfecting station. In winter they are heated with cylinders of hot water.

Each of these vehicles is capable of carrying one adult patient or two children afflicted with the same contagious disease. The ambulance is closed by the driver, who must keep the key in his pocket; but the door can be opened from the interior. So no outsider can open it by inadvertence.

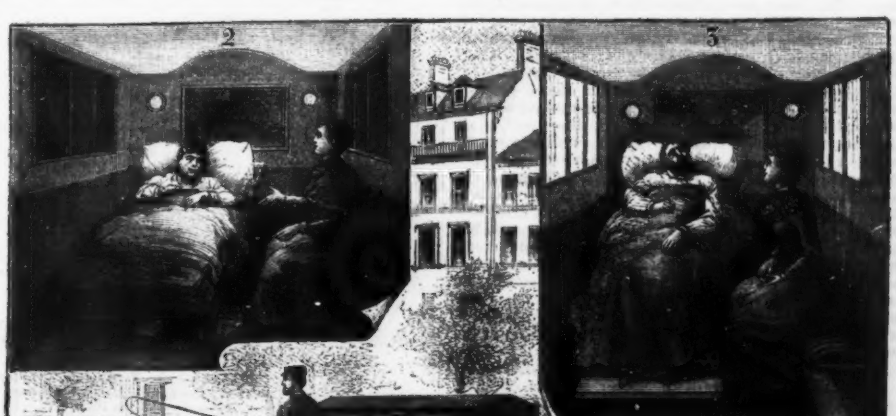
For the carriage of the patients, it became a question of having a litter which could be easily disinfected, and by means of which the patient could be taken, on getting out of bed in his room, and be carried, without being shifted, to his bed in the hospital. In practice, this cannot usually be done. The litters generally employed cannot be carried up stairs, and the patient is changed several times, being carried now upon a chair and now upon different litters in the streets or to the hospital. Moreover, if it is a question of an infectious disease, the chair and the litter may become objects of transmission. Such difficulties have been very happily overcome by the following arrangement devised by Mr. Herbet from directions furnished by the special jury charged with the examination and selection of the vehicles.

The litter put in use in the ambulance stations of Paris (Fig. 3) is jointed, so that the patient can be either seated or placed in a reclining posture without having to be disturbed. It is arranged as an arm chair for descending stairways, and as a bed in the ambulance. The invalid rests on a cushion of pure horse hair which can be passed through the stove for an indefinite period.

The patient having been brought down stairs, the legs of the litter are placed upon the rollers designed to facilitate its introduction or removal through rails arranged in the vehicle. This litter is made of iron plate, painted and varnished. Apertures are punched in the bottom of it, in order to give it greater lightness. For children, a litter in the form of a hand barrow is used (Fig. 2). It is easily seen that these apparatus can be very easily disinfected.

The carriage is effected as follows: Each station comprises a superintendent, two drivers and a groom. The nurses, who are trained, put on for the carriage of the patient a long blouse of unbleached cotton, well adjusted to the neck and wrists, descending to the heels, and buttoning all the way down. The head covering is a cotton cap which incloses the hair and falls upon the neck.

The road costume of the driver is a blouse and a pair of trousers of cotton worn over his ordinary clothing,



1. General view of the vehicle. 2. Interior view, with litter in the form of a bed. 3. Interior view, with litter forming a chair.

PARISIAN AMBULANCE.

and an oilcloth cap which can be easily washed with a disinfecting solution.

The ambulances may be ordered direct by the public, verbally, by letter, by telegraph, or by telephone.

As soon as the notification is received, the station superintendent calls up the driver and nurse through an electric bell, the number of strokes sounded giving the number of the ambulance to be got ready. The

ambulances, moreover, are always ready to start and a horse remains constantly harnessed. In the office there is posted a list showing to what hospital the patient will have to be sent, according to the nature of his disease.

The start occurs in three minutes at the least. On reaching the house, the nurse must not take the carrying of the invalid in charge unless a medical certificate permits her to assure herself of the contagious character of the disease. If the diagnosis is in suspense, the invalid is forwarded to the service designed for this category of patients.

The ambulance must not stop at any point of its travel under any pretext whatever. As soon as it has deposited the patient at the hospital, it must return to the station, where it first enters the yard set apart for disinfection. This operation is effected by means of a liquid projected by the vaporizer of which we have already spoken. The outer clothing of the nurse and driver are placed in the disinfecting stove. The ambulance and its litter are afterward placed in the wagon house. The nurse, before retiring to her apartments, enters a room where she makes her toilet with disinfecting liquids, and takes care not to neglect to brush her hands and nails with care.

These services, as might be expected, are becoming better and better appreciated.

In 1889, the ambulance stations of Paris carried 66 patients, of whom 48 were suffering from contagious diseases. In 1890, the number was 1,850, of whom 577 were suffering from contagious diseases. In 1891, up to December, the number was 6,902, of whom 1,103 were suffering from contagious diseases.

It will be seen from this how well these ambulance stations complete the sanitary institutions that Paris has in so short a time organized with the prompt aid of the municipal council and of the administration of the prefecture of the Seine. Few cities to-day present so ingenious and practical means for the prevention of contagious diseases.—*La Nature.*

GUM ARABIC AND GUM SENEGAL.

THE employment of gum senegal as an adulterant of, or even as a substitute for, gum arabic led the author to investigate the properties of these two gums.

Gum arabic forms rounded or angular, colorless, yellowish, or brownish, and strongly refractive little lumps, while gum senegal is usually in long, straight, or curled cylindrical pieces, but occasionally in mulberry-shaped nodules, and is either colorless or faintly yellow or white, like etched glass, superficially, and lustrous and transparent internally. The two gums are therefore readily detected in the uncrushed condition, but under other circumstances they require further investigation for their identification.

Water dissolves both gums, leaving a residue of wood fibers, these being usually red if from gum arabic, and black from gum senegal. Potassium hydroxide and copper sulphate produce a blue precipitate in both solutions; the gum arabic precipitate is more considerable than the senegal precipitate. Moreover, the former is coherent and rises to the surface, whereas the latter is more flocculent and remains disseminated in the liquid. The precipitates are only very slightly soluble on warming, and are not reduced even on boiling. Under similar treatment, dextrin also gives a bluish precipitate insoluble in the cold, but soluble to a clear, dark blue solution on warming, which solution is completely reduced by prolonged boiling. By heating with dilute potassium hydroxide for some time, solutions of gum arabic or dextrin become amber-yellow; solutions of gum senegal, on the other hand, scarcely alter or are but very faintly yellow.

Mixtures of the gums arabic and senegal behave, with potassium hydroxide alone, like gum arabic; with potassium hydroxide and copper sulphate, like gum senegal. The blue precipitates from mixtures of dextrin with gum arabic or gum senegal are reduced on boiling, provided the quantity of dextrin is not too small; but when the latter is the case, after thoroughly warming, the precipitate must first be filtered off, then, on boiling the filtrate, reduction takes place if dextrin is present. When both gums as well as dextrin are present, the precipitate is washed, dissolved in dilute hydrochloric acid, and the gums precipitated by means of a large excess of alcohol; when settled, they are washed and examined by the above methods.

The examination of a sample of gum arabic may be conducted in the following manner: Dissolve the powdered substance in lukewarm water, examine residue, any gelatinous matter indicating foreign gums; treat the solution with excess of potassium hydroxide and copper sulphate, warm, filter, and examine for dextrin and senegal as described above.

Gum senegal has been stated to be more hygroscopic than gum arabic; but on drying at 105° the former lost 13·39 per cent., the latter 14·56 per cent., and on exposure to the moist atmosphere, the former reabsorbed 6·15, the latter 6·34 per cent. of water.—*Chem. Zeit.*

THE PREPARATION OF QUININE.

THE finely powdered cinchona bark is ground to a thin paste with lime, caustic soda, or sodium carbonate, and extracted with warm paraffin oil. On standing the oil separates, when it is run off and shaken with sulphuric acid. This solution is boiled, and while boiling is neutralized with sodium carbonate and allowed to cool. Quinine sulphate crystallizes out on cooling, while cinchonine and quinidine remain in solution as sulphates. The quinine sulphate is purified by recrystallization after treatment with animal charcoal. The mother liquor containing the other alkaloids is treated with caustic soda, and extracted with weak alcohol, when of the three bases precipitated by the alkali, quinidine and cinchonidine are dissolved, while cinchonine is left behind. The two former can then be separated by means of their neutral tartrates, that of quinidine being considerably the more soluble.

Chemically pure quinine is manufactured by preparing the acid sulphate, which, after undergoing sufficient purification, is reconverted into the neutral salt. The consumption of quinine amounts to 200,000 kilos. annually. The Ceylon bark contains about 2·4 per cent. of quinine sulphate; Java bark 4·9 per cent. and even up to 13 per cent. The more recent cultivations of cinchona bark in Peru and Bolivia are of special importance, such bark yielding about 4·5 per cent. of sulphate of quinine.

SOME EXPERIMENTS ON PETROLEUM SOLIDIFICATION.*

By SAMUEL RIDEAL, D.Sc., F.I.C., Lecturer on Chemistry at St. George's Hospital.

IT has long been known that the mineral oils can be readily gelatinized or converted into a more or less solid mass by the incorporation of various soaps or by the action of certain saponifying substances which occur naturally, and of which the common soap wort may be taken as an example.

During the last few years several patents have been granted for different modes of applying the above general principles, with a view to obtaining a solid product containing petroleum which might be of some commercial utility. When soaps are employed for the gelatinization of the petroleum, a product is obtained which has most of the properties of the soap added, and if the percentage of soap be large, the mixture of soap and petroleum can be utilized as a detergent, and many of the cheaper soaps have a considerable quantity of paraffin incorporated with them in this way. It was, however, with a view of ascertaining what was the best and minimum quantity of foreign material necessary to bring about the solidification of the petroleum that these experiments were undertaken, and as the literature on this subject is very meager, consisting chiefly of patent specifications of inventors who, for different reasons, have not given a comparative statement of the properties of the different products described, it was thought that a short description of an attempt to systematize this subject would not be uninteresting to members of the Society of Chemical Industry. At the present time, to the best of my knowledge, none of these products are on the market in large quantities, but there is a good deal of private work going on, and there would seem to be no doubt that in a short time there will be industrial applications of these products.

* From the *Journal* of the Society of Chemical Industry.

I have grouped for convenience the more important experiments under different headings, and, while they do not pretend to be an exhaustive treatment of the subject, most of the proposed methods for effecting this object will be found to be included. In order to obtain comparative results of the different consistencies of the various products, and thus form a guide for future work with those materials which give the most suitable bodies for the different purposes for which they may seem adapted, one kind of petroleum has been used throughout, and as it was a refined oil used for illuminating purposes, better products, so far as consistency is concerned, would, in the majority of cases, be obtained if a natural oil containing the heavier hydrocarbons were employed.

A.—Solidification by Means of Soap.

It is obvious that various methods of procedure may be adopted both for making the soap and also for its incorporation with the petroleum. After several trials it was found that the most satisfactory results were obtained when the soap was actually made in contact with the petroleum, either simply by the addition of an alkali to a fatty acid dissolved in the heated oil or by saponifying vegetable oils in intimate contact with the petroleum. As already mentioned, the conditions for the best incorporation of crude paraffins as an adulterant of soaps are probably well known, although for obvious reasons there is little public knowledge of these conditions. The experiments under these headings were, however, undertaken with a different object in view, and as in only a few cases more than 10 per cent. of soap was present in the finished product, the results will have little interest to the soap maker. The chief results are embodied in the following tables:

TABLE I.

EXPERIMENTS WITH FATTY ACIDS.

Fatty Acid.	Lime.	Dry Soda.	Aqueous Soda.	Aqueous Ammonia.	Steam.	Sodium Silicate.	Sodium Aluminate.	Litharge.	Nitrous Acid.
Stearic acid	Soap remains partially suspended in liquid.	Translucent solid granular mass.	Granular, opaque, white firm mass.	Firm mass, opaque and white.	Translucent white jelly.	Pure white, pearly, hard mass.	Hard white translucent mass.	.. ..	.. ..
Oleic acid ..	.. ..	Stiff whitish jelly.	Stiff cream-coloured opaque jelly.	Soap formed, separates from the petroleum.	.. ..	Very stiff, flexible, white jelly.	Stiff cream-coloured jelly.	Separation of cream soap from oil.	No separation of solid elaidic acid.
Elaidic acid	.. ..	Soap formed, which separates.	Soap formed, which separates from petroleum.	Soap formed, which separates.	.. ..	.. ..	.. ..	.. ..	.. ..

An experiment was also tried with aniline, oleic acid, and petroleum to see if a solid product would be formed, but gave a negative result. In the above experiments 10 per cent. of fatty acid was employed, and sufficient base to neutralize it subsequently added.

TABLE II.

EXPERIMENTS WITH SOAPS AND BEESWAX.

Solidifying Agent.	Water.	Cane Sugar Syrup.	Dilute Hydrochloric Acid.	Dry Soda.	Ammonia.	Sodium Silicate.	Alone.
Commercial soap.	Forms a viscous liquid in which soap is suspended.	Soap separates out and solidifies at bottom.	Semi-solid flocculent mass floating in petroleum.	.. ..	.. ..	.. ..	.. ..
Dry soap.........	Hard yellow compact mass.	.. ..	.. ..	.. ..	.. ..	.. ..	Soap separates out on cooling.
Beeswax	.. ..	.. ..	.. ..	Soft dark brown buttery mass.	Light yellow sloppy mass.	Soft light-brown mass.	.. ..

TABLE III.

EXPERIMENTS WITH OILS AND FATS.

Oil or Fat.	Aqueous Ammonia.	Aqueous Soda.	Dry Soda.	Nitrous Acid.	Sodium Silicate.	Sodium Aluminate.	Litharge.
Tallow	Remains fluid; slight separation of soap.	Separation of oil and of aqueous soap.	Fairly hard light brown mass.	.. ..	Viscous liquor containing insol. soap.	Fairly hard; cream-coloured; solid.	.. ..
Colza oil.........	Forms a perfectly fluid mass.	Forms soap which separates from the oil.	Forms a fairly hard brown mass.	.. ..	.. ..	.. ..	.. ..
Cotton-seed oil...	.. ..	Complete separation of soap from oil.	Forms a viscous semi-liquid.	.. ..	.. ..	.. ..	.. ..
Suet.............	Complete separation of the soap.	20 per cent. forms a whitish cake; some separation.	Pasty brownish mass.	.. ..	Viscous liquid containing semi solidified soap.	White soap separating from oil.	.. ..
Olive oil.........	Forms an opaque milky liquid.	Gives a yellowish pasty mass.	Semi-solid brownish mass like vaseline.	No separation of solid elaidin.	Highly viscous liquid containing solid soap.	Stiff opaque jelly.	Separation of soap formed from petroleum.
Lard oil	.. ..	Separation of soap from oil.	Forms a thick viscous liquid.	.. ..	.. ..	.. ..	.. ..
Castor oil........	.. ..	Hard firm cream-coloured mass.	.. ..	.. ..	.. ..	Forms a very hard, firm mass; some separation.	.. ..
Rosin.............	.. ..	Rosin soap separates out entirely from oil.	Rosin soap separates out entirely.	.. ..	.. ..	.. ..	.. ..
Linseed oil.......	.. ..	Very little saponification takes place.	Semi-solid yellow sloppy mass.	.. ..	.. ..	.. ..	.. ..
Cocoanut oil	Complete separation of white soap from oil.	Saponifies white, hard, and firm mass.	Fairly hard mass, white and opaque.	.. ..	.. ..	.. ..	.. ..

From the above tabular statements it will be seen that the hardest products at the ordinary temperature and those which are most readily formed are obtained (*a*) by the use of the free fatty acids; (*b*) by making the soap in the liquid. In the latter, the glycerin liberated by the saponification of the oil was not removed, and it therefore somewhat modified the appearance and consistency of the product.

A few experiments were also tried substituting potash for soda and ammonia, and it is interesting to note that with certain oils the products obtained are quite equal in consistency to those obtained with the two former alkalies. Although lime and stearic acid gave an unsatisfactory result, further work with lime and the carbonate on the other fatty acids might yield better products. The results obtained with aqueous potash are summarized in the following table (IV.), but no experiments have as yet been carried out with dry potash, although it will be noticed that very different results are obtained when dry caustic soda is substituted for the lye.

aluminate appears to be novel. Sodium aluminate appears to be superior to sodium silicate with many oils. It is a much more efficacious agent, for example, with both tallow and olive oil, as it renders these oils available for soldifying petroleum, and which could not be effected under the same conditions with water glass. A patent dating so far back as 1883, by S. M. Eiseman (No. 3,972), apparently covers all methods of making soaps in conjunction with paraffin, either by the action of alkali on fatty acids or on the unsaponified fats and oils. This patentee has also devised a method of protecting the granulated petroleum from atmospheric influences and the action of a moderate temperature, by coating the product with a mixture of calcium or magnesium salts and sodium silicate. He draws attention to the hardness of the products obtained with castor oil, and thus confirms what one would conjecture from a knowledge of the soaps made therefrom.

Some interesting products can be obtained by the blending of a soap-solidified petroleum with petroleum

TABLE IV.

EXPERIMENTS WITH AQUEOUS POTASH.

Stearic Acid.	Oleic Acid.	Olive Oil.	Cotton-Seed Oil.	Tallow.	Suet.	Castor Oil.
White pearly hard mass.	Cream-coloured thin jelly.	Soft, cream-coloured mass; some separation of paraffin.	Firm white flaky mass resembling lard.	Soft yellow soap separating from oil.	Soft flakes of soap, with considerable separation.	Firm white mass; no separation.

The procedure adopted to obtain these products varied somewhat with the particular experiment, but the following is a general outline of the method used in the laboratory: 100 cub. cms. (82·1 grms.) of commercial paraffin were heated in a capacious basin on a water bath. The fatty acid or oil used was then added in proportions varying from 5 to 10 per cent. In the case of suet, 20 per cent. was necessary to obtain the best results. When the mixture was at a temperature of about 80° C., it was thoroughly agitated by means of a wheel egg whisk, and then from 1 to 2 grms. of dry soda or an equivalent amount of alkaline solution, etc., introduced. The agitation was then conducted rapidly for a few minutes, during which the saponification of the fat or neutralization of the fatty acid takes place, and an emulsion of the melted soap with the paraffin is produced. In some cases the soap appears to be soluble in the paraffin at this temperature, but the mixture on cooling solidifies. In the best experiments the mixture gelatinizes while still at 80° C., and it becomes difficult to rotate the agitator in the basin. It is obvious that the uses of a solid petroleum which was perfectly fluid at such a temperature would be somewhat limited, but it is more advantageous to determine the melting points of the solid products in the usual way than make any special determination of the temperature at which they become solid on cooling.

The melting points of the product depend on the kind of solidifying agent employed, some being viscous at the ordinary temperature and others varying from 42° C. to 132° C.

Among the vegetable oils employed, the best results were obtained with cocoanut oil and castor oil, both products being hard and white and far superior in these respects to those obtained when olive or linseed oil was used.

The apparent total separation of the resin soaps from paraffin is noteworthy, as it was hoped that the resin acids would form compounds which would gelatinize the petroleum in a similar way to the vegetable fatty acids. The hardness and consistency of these products varies directly with the amount of soap present, those containing the most soap being the hardest, and, as already alluded to, the presence of glycerin when the gelatinization is effected by the saponification of an oil or fat tends to lower the consistency to that of a buttery mass. In the case of castor oil the presence of glycerin resulting from its saponification does not, however, prevent the product from being a solid. The products obtained when dry soda is used in the saponification are usually darker in color, more translucent, and less firm than those made with aqueous soda. Nevertheless, a greater number of good products were obtained with dry soda than when an aqueous solution was used, as the latter class include examples which were absolute failures, the soap produced apparently having no power of occluding or mixing with the paraffin.

On reference to Table I., the influence of water on the combination of finished soap with paraffin will be observed. The product made in this way is substantially that covered by Smith & Pearson in their Eng. pat. No. 3,044, 1889. Desiccated soap refuses to unite with petroleum at the temperature obtained on the water bath, but on the addition of a small quantity of water and continuing the agitation, a product was obtained which when cold formed one of the best, both from its degree of hardness and its permanency in the air. It would seem that water, or possibly glycerin, was necessary to insure the formation of these products, and that the solidification was purely mechanical, the soap frothing with the water and then inclosing the paraffin along with or in place of the air in the small bubbles formed.

The failure of the elaidin and elaidates to unite with the petroleum was a disappointment, as I can find no reference to any previous experiment in this direction. Possibly some of the new methods, such as Schmidt's, for the conversion of oleic acid into iso-oleic and stearic acids might be worked to advantage in conjunction with a petroleum solidification process. At the same time it will be noted that several of the products obtained by solidifying with oleates were very satisfactory.

All these processes for the utilization of various soaps in order to solidify petroleum are probably covered by the existing patents, especially those of Lawson (Eng. pat. 2,971, 1888), and of Smith & Pearson already referred to. At the same time no one has drawn attention to the modifying action of the glycerin if allowed to be present in the finished product. Saponification by means of silicate of soda is covered by Lawson in his patent, but the use of sodium

jelly. When equal quantities of vaseline and refined petroleum are heated together and 10 per cent. of oleic acid and the requisite quantity of dry soda added, a jelly-like and yellow product is obtained which resembles ordinary vaseline in appearance, but of softer consistency and smelling of petroleum. When stearic acid is substituted for the oleic acid a pale yellow translucent jelly is obtained with dry soda, and a pale yellow opaque jelly when aqueous soda is employed. These admixtures may probably be found useful as a lubricating medium and seem to indicate that useful products could be similarly made from a petroleum from which the lighter spirit only had been removed.

In Eiseman's patent already referred to, entitled "Improvements in heating volatile or inflammable fluids and oils for storage, transportation, and other purposes," an apparently essential part of the process consists in the admixture with the vegetable oil and paraffin before saponification of "an acid or acid combination." It is difficult, however, to see what part the acid plays in the process, as, although he uses sulphuric acid and hydrochloric acid in many of the examples he cites, yet with castor oil no acid is employed, "owing to the peculiar acid found therein." As an alkali is subsequently added to bring about the saponification, I have made no experiments in this suggested variation. He further states that when a dry alkali is employed no heat is necessary, but when a lye is used it should be hot, but the temperature should be kept as low as possible. In the experiments done in my laboratory, heat has been found to accelerate if not absolutely to be necessary for the reaction when dry soda is employed, but in no case has the temperature been lower than that obtained on a water bath. On the other hand, Smith & Pearson, who incorporate 3—5 per cent. of dry soap with the oil, recommend a temperature a little above 280° F. while the soap is added, and afterward raise the temperature to 400° F. if necessary. At this high temperature the product is liquid and the process is necessarily complicated by the special closed apparatus required when a body like paraffin with volatile constituents is raised to such a temperature.

Lawson's patent and one by Stitt (No. 8,604, 1888) are both for incorporating petroleum in soap so as to make an improved detergent, and are therefore somewhat foreign to this inquiry.

B.—Solidification with Vegetable Saponifiers.

Experiments have been tried with the bark of *Quillaia saponaria*, which has long been known as producing a semi-solid mass when agitated with a mixture of oil and water. Saponin, the glucoside present in this bark, probably gives it this property, and as it is also contained in horse chestnuts, soap worts, and many plants of the *Sapindaceæ* and *Mimoseæ*, it may be possible to substitute one or other of these for the saponaria.

The use of quillaia bark has been covered by two patents (Grave, No. 13,673, 1888, and Stringfellow, No. 14,832, 1890), but in my experiments with it the products have not equaled in hardness nor consistency those obtained by the use of soap.

The best results obtained by its use are given below.

Experiments.	Results.
1. After Grave's process, using 10 per cent. of saponaria decoction.	A stiff pinkish opaque jelly.
2. After Stringfellow's patent, using 1 per cent. ground bark and afterward adding 10 per cent. water.	A stiff white opaque jelly, which slowly yields its petroleum as a liquid.
3. The same, but using 5 per cent. of bark and the same quantity of water.	White opaque jelly, more permanent than No. 2.

The essential difference in these two methods of working is the substitution of the powdered bark and water for the decoction in the latter process. There is very little difference in the appearance of the product, but it is stated that it is more economical to use the powdered bark, although, when its extraction is properly conducted, the whole of the saponin should be present in the decoction, and thus prevent any waste of the bark.

From the low price of saponaria bark at the present time and the small percentage required, it is probably one of the cheapest materials to use for solidifying oils for transport and storage.

C.—Solidification with other Reagents.

The similarity between the absorption of water and paraffin by soap naturally led one to experiment with other materials which form solid masses with water. Gelatin, glue, albumen, casein, gum, and many mineral substances suggest themselves, but on trying these bodies under different conditions no very satisfactory results were obtained.

1. *Gelatin.*—On melting from 3—8 per cent. of size with a small quantity of water on the water bath, and adding the petroleum, after violent agitation and cooling, the mixture solidifies to a tough jelly. With the smaller percentages of gelatin, it was easy to remove the oil mechanically retained by the jelly by squeezing, and on standing it slowly oozed away, and when the percentage of gelatin was as much as 8 per cent. the amount of water required for solution was sufficient to prevent the paraffin from burning. When bichromate was added to the gelatin mixture before cooling, the product also turned out unsatisfactory, and with tannic acid the product obtained was so brittle that it is difficult to see any use for such a material.

2. Albumen coagulated by warming and with acetic acid did not retain any petroleum.

3. Milk, milk extract, and casein likewise gave negative results.

4. Ghatti gum mucilage and ferric chloride give, as is well known, a thick, gelatinous mass, but the formation of this compound in the presence of petroleum does not prevent the latter from being easily removed again from the mixture.

5. Inorganic precipitation, *e. g.*, alum by ammonia, calcium chloride and borax, zinc sulphate and soda, calcium chloride and a sulphate, gave negative results.

The reliquefaction of these various products by means of heat or by appropriate reagents is a question of considerable practical importance. A ready means of solidifying petroleum for transport and subsequent reliquefaction for use would be a desideratum. Where saponaria bark is the agent employed, the solid can be reliquefied by the addition of a small quantity of dilute acid, probably owing to the decomposition of the glucose into its sugar and sapogenin. Stringfellow has claimed the use of acetic acid for this purpose, and recommends the use of 2½ per cent., which he pours over the surface of the jelly so as to entirely cover it. Mineral acids do not behave so well as acetic acid, although, if the breaking up of the mass is due to the hydrolysis of the glucoside, dilute sulphuric acid would seem to be the most suitable. When a soap is employed, the oil can be reconverted into the liquid state by heat or by warming with a mineral acid. The completeness of the reliquefaction in the case of a soap-solidified petroleum obviously depends on the nature of the fatty acid liberated from the soap. As I have already mentioned, free stearic acid and water form a translucent jelly with petroleum. Hence, if a stearate soap has been used, a warm acid will be required, and the stearic acid liberated immediately removed from the warm oil if a liquid is again desired. With oleate soaps the same difficulty does not occur, as oleic acid forms no solid product with petroleum.

The disadvantages of a solidified petroleum which is liquid at a temperature below 100° C. are obvious if the material is to be used for burning purposes or as a constituent of briquettes. Stringfellow's saponaria product is stated not to flow when burnt; but apparently his jelly is not primarily intended to be used as a fuel. Many of the soap-solidified products melt at a temperature below 100° C., and would be practically useless for such work. Probably a suitable material for a fuel could be obtained by incorporating the solidified petroleum with finely divided porous mineral matter, such as kieselguhr or ground brick. Using the latter, I have found such a mixture to burn very well in the open air, and it might be advantageous to substitute such a lamp for outdoor illumination in place of the naphtha lamps at present employed. The Solid Petroleum Pioneer Company, recently formed to exploit a patent applied for by the Messrs. Clenhall, is apparently about to introduce such a mixture. It may, however, be interesting to mention in this connection that one of the earlier patentees (Eiseman) has already suggested the use of solidified petroleum for incorporation with sawdust, coal, etc., in the making of fuel. In my earlier experiments, using ammonium stearate for the solidification of petroleum, an attempt was made to overcome the difficulties met with in Russia, where this stearate has been used for the manufacture of petroleum candles. Apart from the objectionable smell which such candles emit, the loss of weight owing to the evaporation of the paraffin is considerable. Although only 10 per cent. of stearate is suggested in Russia, my own experiments indicate that about 20 per cent. of stearic acid must be incorporated to obtain a product as firm as ordinary candle material. The loss on exposure to the air may be in part prevented by protecting the surface of the candle with a glaze of some organic material impervious to paraffin. When incorporated with coal dust, the solidified petroleum, if used in large amounts, can replace pitch in a briquette and form a block fuel which readily ignites.

I have already drawn attention to the vaseline-like products and their possible utilization as lubricants. Since putting these notes together, I note that another application for an improved process for solidifying petroleum has been patented by S. Lewes.

A MYDRIATIC ALKALOID IN LETTUCE.*

By T. S. DYMOND.

THE attention of the author was drawn a few months ago to the mydriatic action of an extract prepared at Hitchin from common lettuce, *Lactuca sativa*, when in flower. On examination, the mydriatic action was found to be due to an alkaloid. The extract closely resembled belladonna extract in appearance, smell, and taste; but a dose of 5 grains had been given without injurious effects. Three other commercial extracts of lettuce were examined, viz.: an extract of wild lettuce, *Lactuca virosa*, prepared according to the directions of the British Pharmacopœia, the history of which was unknown, and extracts of both the wild and the cultivated lettuce, prepared at Market Deeping, in Lincolnshire. An extract of that variety of the cultivated

* The substance of a communication made to the Chemical Society on December 3; reprinted from *Pharm. Jour. and Trans.*, Dec. 5, 1891, p. 449. From the Research Laboratory of the Pharmaceutical Society of Great Britain.

plant known as Cos lettuce was also examined. They all contained an alkaloid which had a very marked power of dilating the pupil of the eye. Finally, a dried specimen of wild lettuce, collected when in flower, was examined. It contained a mydriatic alkaloid.

The impure alkaloid obtained from the extract was a light brown sirup, which possessed powerful mydriatic properties. In order to purify it, it was converted into the oxalate. The alkaloid recovered from the pure oxalate, when crystallized from chloroform, closely resembled hyoscyamine, both in appearance and in melting point. The aurochloride was then produced by the usual methods, and this, after recrystallization, was obtained in the shining flat needles characteristic of the aurochloride of hyoscyamine. The estimation of the gold and the base in this compound showed that the alkaloid was one of three isomeric mydriatic alkaloids having the formula $C_{17}H_{23}NO_3$, while its melting point was 159·75° (corr.), and closely corresponded with that ascribed by Ladenburg to the aurochloride of hyoscyamine. The plant does not appear to contain a second mydriatic alkaloid, although it must be remembered that only small quantities of material were operated upon.

The author has thus shown that both wild and cultivated varieties of lettuce, especially when the flowering stage is reached, contain hyoscyamine, the mydriatic alkaloid occurring in *Hyoscyamus niger*, *Atropa belladonna*, and other plants belonging to the natural order *Solanaceæ*, and it is probable that to the presence of this alkaloid the sedative and anodyne properties of extract of lettuce are due.

That this important constituent has been until now overlooked is probably due to the fact that, in chemical investigations upon lettuce, the dried milk sap, lactucarium, has alone been examined, although its value as a sedative and anodyne is by no means established. The author found that lactucarium of both English and German manufacture was devoid of mydriatic properties and contained no alkaloid whatever.

The fact that lettuce contains a poisonous alkaloid is not of great importance in connection with its use as a vegetable, since it is only used for this purpose in the early stages of its growth, before the bitter milk has been produced, when the hyoscyamine is only present, if at all, in minute quantities. The amount of mydriatic alkaloid in the extract prepared from garden lettuce when in flower is not more than 0·02 per cent. Nevertheless, cases have been recorded in which the immoderate consumption of lettuce has led to unpleasant and even fatal results. Lettuce belongs to the natural order *Compositæ*. This is the first occasion on which hyoscyamine has been found in plants not belonging to the natural order *Solanaceæ*.

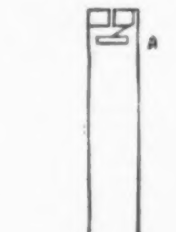
The author's thanks are due to Messrs. W. Ransom & Son and to Messrs. Wright, Layman & Umney for furnishing him with specimens and information.—*Am. Jour. Phar.*

APPARATUS FOR MEASURING LIQUIDS QUICKLY.

By Alex. F. Reid, of Bonshaw, Stewarton, N. B.

In some laboratories many solutions have to be measured out, and to do this quickly is much to be desired. The following apparatus, which can easily be made, I find very serviceable in rapidly measuring out definite quantities of liquid:

A piece of glass tube, A B, is taken, and a cork is



inserted in each end. Through the top cork a small hole is bored; this is closed on the under side by a valve of India rubber cloth with a piece of cork attached to it. Through the bottom cork are bored two holes of about equal size, through which are passed two glass tubes. Two clips are attached to two pieces of India rubber tube at the end of each of these glass tubes, as shown in the figure. The liquid is run into the apparatus through one of these tubes from a reservoir by opening the clip. The liquid rises and lifts the piece of cork, thereby closing the valve. There is now the desired quantity of liquid in the apparatus, which can be run out by opening the other clip, the valve meanwhile falling down, as shown in the figure, ready to let the air escape in filling again.

The same apparatus makes a good burette if the tube, A B, is graduated and a little longer, as no time is lost in filling it to zero. It can thus be worked very quickly.—*Chemical News.*

PROSCENIUM CURTAINS.

In a paper on theaters and music halls, published in the *Building and Engineering Journal* of Melbourne, Mr. Ernest Woodrow describes the various curtains before the public as: (1) Single wrought iron plates, and wrought iron plates fixed on a frame, with an air space between. (2) Wrought iron plates and wire gauze combined. (3) Asbestos cloth in various forms. (4) Canvas curtains with water spray. (5) Water spray curtain. Referring to each of these, the author says: What is required is a fire-resisting surface not affected by the great heat of a fire on the stage, which will prevent the passage of flame and smoke into the auditorium; a surface not affected by water thrown upon it when it is heated, a surface sufficiently rigid in itself to resist falling timber, etc., upon it, and one that shall not be too heavy to be raised and lowered. Iron plate curtains buckle and twist, allowing flame and smoke to pass, they convey heat, and are heavy; wire gauze does not withstand falling bodies, and smoke and flame will pass through it if damaged; asbestos is fragile, and becomes easily torn; water and canvas depend altogether upon the water being spread over them; water spray will not stop the passage of flame and smoke. Mr. Max Clarke has invented a *protected* iron curtain which is said to fulfill these conditions. It is an open framework of iron and wire, protected by a covering of silicate cotton and slag wool on each side. This cotton is covered with wire netting, and forms an absolutely non-conducting material, and can be covered on the auditorium side with green baize, to look like a green curtain, or have painted canvas, and take the place of the "act drop." This curtain is pliable, and will adapt itself to any strain, is fire and smoke proof, and can be raised by man or hydraulic power.—*Building News.*

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